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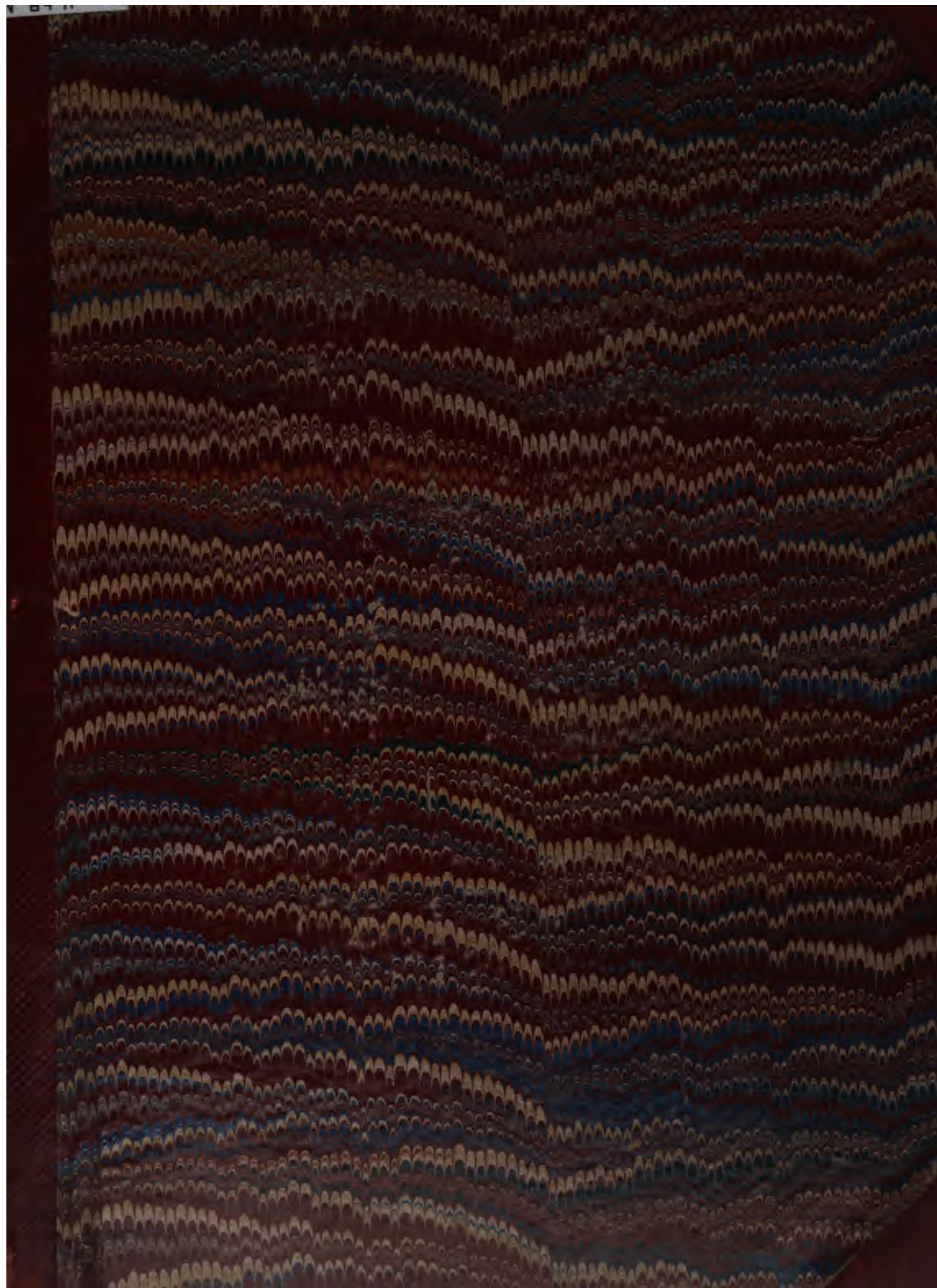
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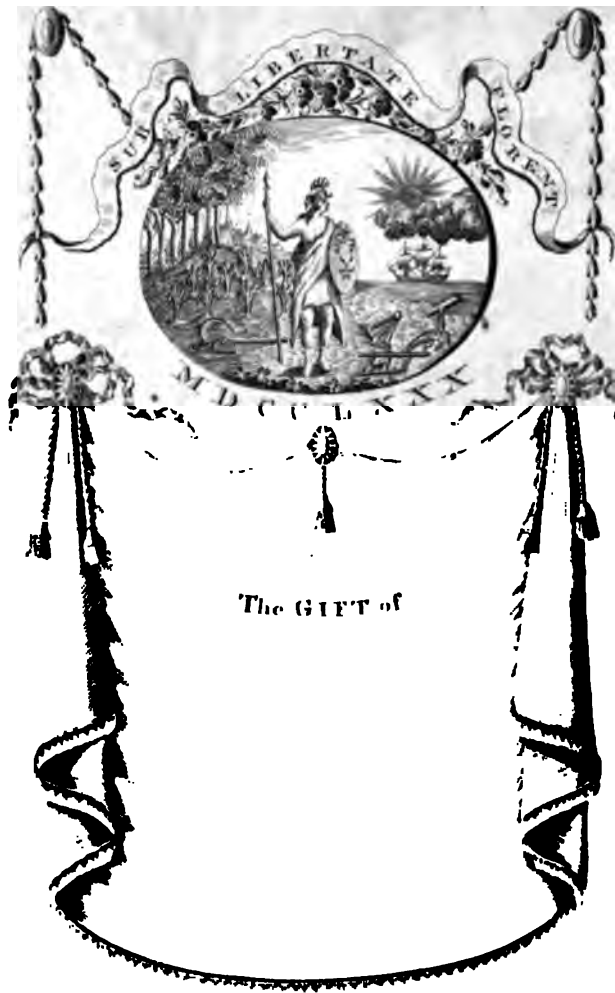
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5.
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To The American Accademy of Art & Sciences
from John Adams

1. The first part of the document is a list of names and addresses, which appears to be a directory or a list of subscribers. The names are written in a cursive script, and the addresses are listed below them.

AN
ATTEMPT
TO PROMOTE
THE COMMERCIAL INTERESTS
OF
GREAT-BRITAIN.
IN TRACTS.

BY MR. LANGWORTHY.

*For want of opportunity, some inaccuracies in this work
still remain uncorrected.*

ANALYSIS OF TRACT I.

Dedication, Introduction, and Plan of the work.

Of the production, manufactures, and modes of consumption of Copper, Brass, Tin, Iron, and Lead, in Great-Britain.

Of partialities that have obtained, in some Manufactures of Metals, employing but few hands, to the depression and injury of others employing more hands, and of much greater importance to the general interests of the community.

Of the modern extravagant modes of consuming Copper, and first by Ship-sheathing.

Of the immense monopolies of Copper which that consumption has induced and encouraged.

Of the effects which such consumption and monopolies have had on the Brass Manufactories, and on the œconomy and expenditures of the Navy of Great-Britain.

Of the Mines of Cornwall and Anglesea, the intrigues of the Monopolists of Copper, the dangers to be apprehended to our Metallic Trade, from the present precarious state of Copper-Mining, and of the most effectual means of averting those dangers.

Of opening new Mines for Copper, and proposals of a more general, impartial and effective spirit of enterprize in mining.

General history of sheathing Ships, with details of facts respecting the inefficacy of Copper-sheathing, and respecting Ships that have foundered from the inefficacy of Copper, in Bolts, Nails, Rudder-works, &c.

Impartial view of the advantages and disadvantages of copper, in various purposes to which it is now commonly applied.

Of the methods hitherto used to prevent Corrosion in Metals, and the Author's improvements in consequence of facts ascertained and hints proposed by Dr. WATSON in his Chemical Essays.

The superiority of the Author's said improvements over every mode of resisting Metallic Corrosions hitherto known, and a detail of experiments made under the directions of the Lords of the Admiralty, Master-General of the Ordnance, Officers of the Navy and Army, Merchants, &c. with their respective correspondences, certificates, and other documents demonstrating that superiority.

Reasons for abolishing the use of Copper, in divers purposes, in which it is now misapplied and wasted; for substituting the Author's prepared Anti-corrosive or Blanched Iron, especially in the metallic works of Ships, Ship-sheathing, civil Architecture, and Culinary Vessels, and for applying it to Fire-arms.

Comparative view of the advantages of unqualified Iron with those of Copper in Naval Architecture, and decisive superiority of the prepared Anti-corrosion, or Blanched Iron, to both.

Calculations of the comparative expence of Copper and of the Anti-corrosion Iron in the structure of a 74-gun Ship, and the aggregate saving on the whole British Navy demonstrated therefrom.

Reasons for an immediate and general substitution of the Author's peculiar preparations of Iron, in preference to any other now extant, for all culinary vessels necessarily made of Metal.

Of the establishment of a Manufactory of the Anti-corrosion or Blanched Iron and the plans adopted to give full effect to the design.

Conclusion.

AN
ATTEMPT.
TO PROMOTE
THE COMMERCIAL INTERESTS
OF
GREAT-BRITAIN.

BY WILLIAM LANGWORTHY,
OF THE HONOURABLE SOCIETY OF THE INNER TEMPLE.

TRACT I.

A GOOD PATRIOT, AND A TRUE POLITICIAN, ALWAYS CONSIDERS HOW HE SHALL MAKE THE MOST
OF THE EXISTING MATERIALS OF HIS COUNTRY. BURKE.

BATH, PRINTED BY R. CRUTTWELL, FOR THE AUTHOR; AND SOLD BY
C. DILLY, POULTRY; J. DEIGHTON, HOLBORNE; AND J. EVANS,
PATER-NOSTER-ROW, LONDON.

MDCCXIII.

KG5003



TO THE
RIGHT HONOURABLE WILLIAM PITT.

SIR!

THE following sheets contain some truths, that I apprehend may be made the means of benefiting my country; it is therefore both my duty and my inclination to make an offering of them to you. They profess the intention of promoting the *commercial* interests of Great-Britain,—Who has so strong a claim to them as that statesman, under whose influence those interests have flourished and increased beyond all historical example! They pretend to *patriotism*.* Who will charge him with flattery that says, it is a virtue emphatically your own; congenial to your very name—a virtue whose flame has, in your illustrious house, ascended with equal steadiness and ardour, whether exposed to the intemperate clamours of popular phrenzy, or the cooler insolence of disappointed pride?

The *respectable* libellers by whom you have so often the honour to be personally charged with every physical, as well as political evil, that exists or is fancied to exist in the nation, have asserted that the bankruptcies, which have of late been so frequent, indicate that, under your

* For some small instance of my love for my country, see page 141 and the appendix.

administration,

administration, the riches and credit of this country have been reduced to the verge of destruction, and ~~that the party, the whole, and the~~
~~some sagacious pamphleteer or~~
 other is daily assuring us that our liberties are annihilated:

When these politicians have demonstrated how a great nation shall have *exactly* as much credit, and *exactly* as much liberty as it wants, and *no more*; that is to say, exactly as much *perfect* credit as it wants, without the least tincture of *false* credit, and exactly as much *liberty* without the least contamination of *licentiousness*, I will admit that you have wanted the perfection at which a minister *may* arrive; but until that time, they will excuse me if I believe, that our late trading and commercial failures have, in general, arisen, not from *poverty*, but from an *overgrown credit*, that has shot out in every direction from the luxuriant stock of our national wealth; and that the profligate libels of the day, so far from indicating that we have *no liberty*, precisely prove that we have *too much*.

“ A city ~~is a ship, and divisions are the leaks,~~
 “ through which, while the mariners fight one with another, the water
 “ enters and drowns all: the wise pilot, who steers, ought to stop those
 “ leaks, and make up the breaches of division; and reserve himself,
 “ without trusting any other for the helm, and especially not to place
 “ there any capricious heads or factious spirits; but of all things to be
 “ sure to keep himself lord and patron of the vessel.” †

† Giraffi - *Life of Masaniello*

May

May you continue to act up to the spirit of this maxim—may your great and comprehensive views be pursued with full effect, unimpeded by the violence and mutability of contending parties—unfrustrated by the fermentation and malignities of disaffected factions.

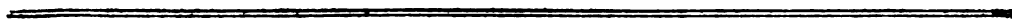
I have the honour to be, Sir,

Your most obedient,

and most faithful servant,

Bath, Sept. 3d, 1793.

WILLIAM LANGWORTHY.



ADVERTISEMENT.

THE publication of this Tract has been delayed by some difficulties, which prevented the establishment of the **BLANCHED IRON COMPANY**, and the arrangements necessary to give effect to the design of the work.

The Author is happy to add, that Mr. Cranch, the gentleman whose death is lamented in a note (page 110) recovered from his illness; and, as it would be attended with much inconvenience to rescind the note, he hopes Mr. Cranch will forgive him for publishing it.

February 1st, 1794.

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of the Admiralty, Master-General of the Ordnance, Officers of the army and navy, Merchants and others, to prove the superior utility of this last-mentioned Manufacture, and the importance of its application to Metallick Works in naval and civil architecture, military, and various other important purposes.....	70
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AFTER spending half a million a year in getting Copper out of the bowels of the earth, we calmly look on while half of it is wasted in the sea, in coppering ships, &c. and in other extravagant, pernicious, and absurd modes of application; as if this rich metal were as generative as cresses; or as if the consumption of it might be supplied, like annual plants, by certain and successive production: The consequences are, that an immense proportion of copper is (to every useful purpose) daily annihilating, our shipping is destroyed, and our metallick manufactures are depressed and ruined.

As the King, the Lords, and the Commons, are the members of our excellent Political Constitution; so the Miner, the Manufacturer, and the Merchant, may be considered as the constituents of our Metallick Commerce. To preserve that balance which alone can insure permanency, as well as general success to this commerce, the interest of each constituent must be relative and reciprocal; and as the genius of the political constitution extends equal right and equal protection to every subject of the state, from the highest to the lowest, so the œconomy of every metallick production in our country, and of every several manufacture, trade, and commerce, resulting from it, should be equally and impartially the object of political discipline, protection, and encouragement.

The reader is requested to correct with his pen the three following Errata, as they affect the sense:

Page 72, line 12, instead of *eris operibus*, read *non augeat*.

Page 75, line 7, for *twenty* read *seventy*.

Same page, subnote, line 3 from the bottom, for *or* read *on*.

AN
A T T E M P T

TO PROMOTE THE COMMERCIAL INTERESTS
OF GREAT-BRITAIN.

INTRODUCTION, AND PLAN OF THE WORK.

IN the present period of extending intercourse, and of commercial rivalry, every invention or hint, that may enable us to maintain the advantages we have gained in the common career of nations, will doubtless be received with candour.

Ambition of conquest begins, every where, to give way to the pursuit of gain, now generally considered as the grand interest of states, while widely-extended dominions are compared to garrisons on too large a scale, which cannot long be defended against a vigilant, vigorous, and active enemy, deriving the means of war from the arts of peace.

Local situation, superior industry, commercial habits, and great *wealth*, at present give a decided pre-eminence to the British Merchant, on the great theatre of trade and navigation of the present moment. But, there are other countries highly favoured in respect of situation; and the spirit of liberty, rising in other parts of Europe, will eventually induce commercial habits; and commercial habits will, in the natural course of things, produce fortunes that will enable their possessors to undertake as extensive concerns, and give as long credits, as any that can spring from the same sources in this island. One source of superiority, however, is more especially our own—belongs to us in the character acknowledged to be peculiarly ours by the greatest wits of foreign countries*—and may be expected to be enjoyed by us longer, and in a higher degree, than by any of our neighbours; as being of a more spiritual, and consequently of a less changeable nature than any of those just mentioned, depending upon operations of the mind, not to be controlled by the accidents of fortune—upon associations of ideas and combinations of principles, or powers, without end.

MECHANICAL INVENTION is now, and may continue to be, a fertile source of improvements to the British manufacturer and merchant, as well as to the nation at large, even after other states and kingdoms shall have, in their progress towards a state of civil liberty, raised themselves to a level with us in the scale of comparative advantages in general.

Mechanical

* "The English are a nation of philosophers." Voltaire.

Mechanical Invention is a field that can never be exhausted; nor reduced, like overwrought land, to a *caput mortuum*, by the strongest excitement or fermentation. On the contrary, each new discovery prepares the way for another, by presenting more and more points of comparison, as well as subjects of observation; by leading us, as it were by the hand, to the happiest modes of analysis, and by enlarging the circle of analogies, which may suggest hints for farther and farther investigation; so that a man of the present times may, without presumption, hope to improve progressively on the inventions of his predecessors, in as much as he possesses a greater power of instrumentality, as well as a wider field of observation: and it may not be vain to hope that future ages will, in the like progression, improve upon the inventions of the present and the past. Therefore, while common (not to say vulgar) industry may enliven and crowd the shores of America, Ireland, the Netherlands, France, and Spain, mechanical invention may yet prolong the present general superiority of Great-Britain to distant ages.

The Mechanical Inventions, that have been produced within these last sixty years, have given more life and vigour to the manufactures, trade, and commerce, of this kingdom, than they had received for centuries before.

It is these chiefly that have raised, and must raise, the value of our natural productions, and are the chief support of the landed interest; they have continued the existence of trade, under the pressure of wars and enormous taxes; and it is to these principally, among other

improvements, that we are to look for salvation from the disaster, which must otherwise accrue from so enormous an accumulation of national debt.*

In the countenance and the patronage, therefore, of a generous public, the author of this essay hopes to find a counterbalance to the many difficulties which he has to encounter, who attempts to bring forward any new invention or proposal, whatever may be its nature, or its advantages to the community.

What is the usual fate of a projector? After multiplied experiments, he surmounts many obstacles of a *physical* nature, and by unwearied industry and perseverance, feels as it were his way to his end or object. His problem solved, and his discovery fairly made and established, he has yet to contend with *moral* difficulties, in the interest, real or imagined, of one class of men; the ignorance and prejudice of a second, and the jealousy and envy, perhaps of a third; in so much, that he is often (after spending his last shilling on his invention) reduced to the necessity of shrinking from his undertaking, with vexation and disgrace, and hiding his face from the scorn of the world.

But;

* It has been said, that the national debt amounts to nearly the value of the soil of Great-Britain. The land-tax, therefore, can never pay either the debt or interest. To what then are we to look for these, but to our manufactures and trade, improved and extended by the ingenuity and industry of our inhabitants. The Chancellor of the Exchequer, in the year 1786, in his speech on the treaty of navigation and commerce with France, said, that out of every shilling expended for labour in manufactures, four-pence entered the Exchequer in taxes.

But, in the present enlightened and liberal age, the author of the contrivances which are the subject of the following sheets, which are intended to remedy the present alarming scarcity and dearth of COPPER METALS, and in various respects, to secure the purposes of health, convenience and comfort, as well as to promote, in an unbounded extent, the GRAND COMMERCIAL AND POLITICAL INTEREST OF GREAT-BRITAIN is encouraged to hope for a better fate. For, in proportion as an age is enlightened, men entertain expanded views, and approximate and combine things, by a more extended, as well as subtle bond of union. They can distinguish the links in a chain of necessary connection, from the vagaries of overheated imagination, the summits of distant mountains from clouds.

THOUGHTS ON THE IMPORTANCE OF BRITISH MANUFACTURES TO THE STATE,
AND ON WHAT THEIR SUCCESS CHIEFLY DEPENDS.

DOCTOR CAMPBELL, in his *Political Survey*, and other writers, have shewn, with great truth and patriotic exultation, that GREAT-BRITAIN, most happily situated for commerce and naval power, and possessing the command of colonies, waste-lands, seas, harbours, navigable rivers and lakes, has not yet come near to the summit of her improvement; but has still a wide field for advancement

ment in national wealth and grandeur. But it is not the improveability of soil, or the extension of agriculture, fishing and navigation, that are the only, or, perhaps, the principal supports of British importance.

She has still a subject of greater and more animating hope in the improveability of art,—in the progress of science, which enlarges the dominion of man over the works of nature,—in the application of those superior powers of invention, by which she is so honourably distinguished, to the various purposes of manufacture, for converting the productions of the soil into all the conveniences and comforts of life; and appropriating *things*, which are the gift of GOD, to their proper and most advantageous *uses* for the service of MAN.

It is, if I may be allowed the expression, the *personal*, and not the *real* estate of Great-Britain, that is the support of her magnificence. It is not in her lands, but in her manufactures, her trade, and naval commerce, in the industry of her inhabitants, that her riches chiefly lie. It is not that her vegetable, animal, or mineral productions are, in themselves, of any very material value; it is the labour of the people that renders them so. If our wool and our hides, as they are shorn and stripped from the backs of the animals that produce them;—if our iron, copper, tin and lead ores, as they are dug from the mines;—if the cotton, the flax, and hemp, the productions of our colonies and of the mother country, were sent to foreign markets in their crude state, how *trifling* would be their returns! But when,
by

by the application of the arts and sciences, and the ingenuity and industry of the people, they are converted into cloths, leather, and metals; and these again are wrought into the various specific forms of which they are respectively susceptible, for the use and accommodation of mankind, then how *prodigious* are their returns!

It seems then to be the interest, as well as the duty, of the governing power of such a state, to be constantly directing the ingenuity of her inhabitants to the discovery of means to increase the value of her crude productions, and in finding out for each the purposes it seems best calculated to answer; and, as occasion shall require, to enact laws for providing that such commodities as are capable of being increased in value by manufacture, should not be consumed in an unmanufactured state at home, when others, less capable of improvement, will answer as well; and that such commodities should also be carried to the highest pitch of improvement and value, that we are capable of giving them, before they are suffered to be sent to any foreign market. Let us apply this doctrine to metals that are the natural product of Great-Britain.

Iron, copper, tin, and lead, are the principal. The first is produced in so great a quantity, in England, and most countries of Europe, that there is no danger of its being exhausted: the production of the second, in England, is precarious: that of the third is confined to small portions of Cornwall and Devonshire; and the fourth is sufficiently abundant in various parts of the kingdom.

The

The first and second are capable of great improvement by manufacture: the third is essential, among many other purposes, to those of health; and the last may be rendered considerably more important than it is, by being applied to many of the purposes to which the second and third are at present misapplied.

Iron, in the mass, is of very little value, not a halfpenny per pound weight; when wrought into bars it is worth three-halfpence; converted into steel, and wrought into buckles, buttons, razors, trinkets, &c. it is increased to every degree of value from four-pence to three hundred pounds sterling;* but, so plentiful is this metal, that we still with safety apply it to articles of the most lavish consumption, and of the least intrinsic worth, without endangering the interests of the more elaborate manufactures.

Copper, in a similar state, that is, in the mass, is much more valuable, because it is much more scarce. It is, at this time, worth one shilling per pound; when manufactured into sheets for working up into furnaces, boilers, culinary vessels, sheathing for ships, coverings for buildings, &c. it sells for thirteen-pence per pound; but when converted into brass, pinchbecks, &c. and wrought into buckles, buttons, trinkets, wheels for machines, clocks, watches, &c. &c. it is increased to—from five to five hundred times its original value.

* It has been said that a pair of steel shoe-buckles has been made for the Prince of Wales, for which the manufacturer charged two thousand guineas.

It

Tin, by any mode of manufacture with which we are at present acquainted, cannot be increased to above three times its worth in the unmanufactured state.

Lead is so incapable of improvement, that, in any state, it is not worth more than two-pence per pound.

It seems then to be an essential part of our political œconomy to cherish and promote, as much as possible, the manufactures of Macclesfield, Sheffield, and Birmingham; and, in short, every place and circumstance which may tend to increase the value of our crude iron and copper by manufacture; but the manufactures of copper (so essential a material in all our most valuable mixed metals) appear to demand a most especial attention: it should be the object of parliament to cause this metal to be applied to as few purposes as possible, in the mass, or in sheets, or other large quantities; and to no purpose whatever that may be answered by metals more plentifully produced, less capable of improvement by manufacture, and which, consequently, can be better spared for purposes of great consumption: and, as there are in some parts or other of the world markets always open for the reception of such manufactures, they only want to be increased to add to the riches of which they are at present the sources.

The permanent success of our manufactures depends most immediately and essentially on a constant and regular supply of such crude
c
commodities

commodities as are made use of in them; and that supply can only be kept up by wise and judicious regulations of the exports and imports, and by œconomy in the application and consumption of such commodities: for, if by any inevitable national calamity, or, as it often happens, by the selfishness of individuals, the manufacturers be deprived but for a short time of the materials necessary to their manufacture, they receive such shocks as the industry of years cannot recover. And, should the deprivation continue, the manufacturers steal insensibly away to other countries, establish their manufactures there, and raise ruinous competitions with those who remain at home.

If this be true, and if the prosperity of Great-Britain depend chiefly on the success of her manufactures, it is the duty of the British Legislature to watch these objects with the greatest care and most incessant attention; yet it happens that they are in some important instances totally neglected. This is especially true with respect to the exportation and waste of metals in general, but particularly copper. The present extravagantly high price of copper, together with the unsatisfied demands that are made for it by the brass-makers and workers in metals, and the present precarious state of our principal copper mines, is become truly alarming, and calls for the immediate attention and interference of the legislature.

Though COPPER is the basis, or principal ingredient, of our most valuable coloured mixed-metals, brass, gun-metal, bell-metal, pot-metal,

metal, speculum-metal, prince's-metal, pinchbecks, and all the variety of those compounds which constitute our metallic trade, and without which that trade must soon be lost; yet there is not one single law in existence to regulate the exportation of copper, or the mode of consuming it: in consequence of this it has been left to a set of individuals to monopolize and manage the price of it as they pleased; and they have so availed themselves of this opportunity, that, unless some very speedy and effectual steps be taken to counteract the effects of their practices, the consequences to this country may, in a short time, be as ruinous as they are at present alarming. From the contrivances of these men, this important article has, within a few years, nearly doubled its price; and though our mines in Cornwall still produce it in great abundance, yet so greatly increased are our metallic manufactures, that the brass-makers, and other metallurgists, who use it in their compositions, have been thrown into difficulties which many of them have not been able to surmount. As this high price, and this seeming scarcity, are thus injurious to the manufacturer, it becomes necessary to investigate the subject, that, by discovering the cause, we may invent and consider how to apply a remedy.

It is an incontrovertible position, that the advance in price of any article of trade is, in general, occasioned by a scarcity of such article; and, in articles of trade and traffic, there are two kinds of scarcity,—a *real* one, and an *artificial* one;—a *real* scarcity, brought about by a failure in the production, or an extravagance in the use of such articles;

an *artificial* scarcity, occasioned by a monopoly of them;—each, to the state, equally injurious in its tendency, though not equally capable of correction; the one arising from a deficiency in nature, the other from the iniquity of man.

In order to discover to which of these causes we may attribute the present high price and apparent scarcity of copper, it will be necessary to know the state of our copper mines, the quantity of copper they have annually produced for a few years past, their present production and situation, and the manner in which this production is and has been disposed of. In order to this, I shall first take.

A CONCISE VIEW OF THE RISE, PROGRESS, AND PRESENT STATE OF THE
COPPER MINES OF GREAT-BRITAIN.

CORNWALL and Wales are the only parts of the British dominions, except a small portion of Staffordshire and Derbyshire, in which copper has for many years past been *plentifully* produced; but, 'till the discovery of the great bed of ore in the Paris-mountain mine, in the isle of Anglesea, about fifteen years ago, no great quantity was produced in *Wales*.

In

In the county of Cornwall, copper ore is so deeply secreted in the bowels of the earth, that 'till the application of hydraulics, and mechanic philosophy, to mining for tin, in that part of the world, it was known nothing of; so that, notwithstanding the fertility of this county in this metal, it was never celebrated for the production of it until within the present century.

In the reign of King James the first, however, NORDEN, in his "*Survey of Cornwall*," intimates that there were rich copper mines in that county, and that their worth was extenuated by private pryers into the secret, and covertly followed for their own gain: and CAREW, so long ago as the reign of Queen Elizabeth, makes a similar observation.

I can find no account of the manner how the knowledge of this ore first got into Cornwall, or in what particular spot it was first discovered. Indeed, under the circumstances of the secrecy with which the first adventurers upon it conducted themselves, it must at any time have been difficult to get at it, nor is it material to my purpose.

There is no doubt, however, that it was met with in working tin mines long before it was known by the miners to be valuable. No longer ago than the beginning of the present century, thousands of tons of it were thrown into the sea as a useless mineral, which the miners called *poder*. And long since that time some gentlemen from

Bristol

Bristol got among the mines and bought the ore for about two pounds ten shillings per ton; and it was not 'till the Brafs-wire and English Copper-Companies were opposed by others, that the miners had any sort of idea of the worth of this metal. About seventy years ago there were three mines, very productive, in the parishes of Ludgvan, Camborne, and Illugan, and the Copper-Companies confederated and bought the ores at their own price, 'till a gentleman from Wales opposed them and raised the price to seven pounds per ton. Soon after which, upon the plan of ticketing being introduced, it rose to nine pounds per ton.

COPPER is not often wrought, in very great abundance, in the mines in Cornwall, until they are sunk below the depth of fifty, and draw on towards an hundred fathoms; and it unfortunately happens, that the ores of most mines, both of tin and copper, are richer in quality near the surface, and grow poorer in quality in proportion to their depth and the enlargement of their lodes or veins.* On which account new mines are attended with less expence, and though less productive of ores than when sunk deeper, yet, from the richness of what they do produce, and the facility of getting that produce, the adventurers in general are pretty amply rewarded.

* Some miners, who consider themselves pretty intelligent in the science of mining, with whom I have lately conversed, have doubted this; but I rather think that their doubts arise not from observation, but from the want of it. The Smelters can set them right.

One might naturally think, from this circumstance, that it would be wiser for the miners to pay more attention to shallow than to deep mines: the contrary, however, in practical mining, seems to be the case; for if a mine, when first discovered, throws up a large profit to the adventurers, and soon after fails, to their loss and detriment, they nevertheless patiently pursue their object; and accordingly, several mines, although they have frequently been unproductive by the way, that have been pursued, to the depth of one hundred and eighty or one hundred and ninety fathoms; and some are now successfully working beyond that depth.

And, though the produce in deep mining has not always paid the *miner* handsomely, the public is fairly presumed to have been benefited; because, however expensive, such works have always produced great quantities of ores; and consequently, at all events, so much has been added to the national stock of materials for manufacture and commerce.

The immense quantities of copper ores that have been raised in Cornwall, have been produced from but few mines; and even now, that the spirit of mining is at a higher pitch than was ever before known, there are not above five or six important mines in the county.

But, though this method of pursuing mines to such considerable depth has been hitherto productive of such beneficial consequences, as it is a maxim that no mine can, according to the present mode of working,

working, pay her costs beyond two hundred fathoms, and as the major part of the great mines are nearly arrived at this point, it may soon be lamented by many adventurers, that they had not rather directed their industry to new ground, than to have proceeded to depths from whence the produce cannot be extracted but by such vast machinery and enormous expence.

The increased production of copper in Cornwall, since the ore has been known there, has been surprisingly rapid. It is not more than seventy years ago that the miners first began to entertain any just ideas of the value and importance of copper ore; and we have no accounts of sales of copper, that I know of, 'till the year 1726.

In that year all the copper mines of Cornwall produced only five thousand tons of ore; and the average annual tonnage for the subsequent ten years did not exceed six thousand four hundred and eighty tons. During this period the average price per ton was seven pounds fifteen shillings and ten-pence, which made the annual amount seven thousand three hundred and fifty pounds; and the ten years amount seventy-three thousand five hundred pounds.

In the year 1739 the tonnage was eleven thousand, and the next year it sunk again to five thousand. It did not get up again to eleven thousand 'till the year 1751; and from that year it continued to increase, upon an average, about a ton a year, 'till the year 1770, by which

which time it was increased to thirty thousand seven hundred and seventy-six tons per year. But as it increased in quantity it decreased in price; and though the mines grew deeper, and of course more expensive, it was then reduced to six pounds fourteen shillings and sixpence per ton.

A few years after this, copper ore began to rise again, and got up to about eight pounds; and, just as the Cornish men thought they were about to turn their mines to great advantage, viz. in the year 1776 or 1777, a formidable rival started up against them in the isle of Anglesea.

At this time, fine copper was from seventy to eighty pounds per ton; but in a few years, by the rivalry which naturally took place between the miners of Cornwall and Anglesea, it was reduced to between fifty and sixty. The ores at the Paris-mountain mine, during this period, were reported to produce two thousand tons of fine copper annually; and the Cornish mines were computed to produce, annually, between forty and fifty thousand tons of copper ore, which would give about five thousand tons of fine copper; so that the Anglesea mine produced about two-fifth parts as much as the mines of Cornwall.

The Paris-mountain mine lies in the side of a hill, and being from this situation always dry, produced the copper ore at a much less expence than the mines of Cornwall did. To this advantage the Anglesea

miners added another, by an œconomy never before that time adopted. The poverty of their ores was in one sense the cause of enriching these miners; for having discovered that these ores were too poor to pay for smelting them in the usual way, and that they contained not only the copper, but a more than usually abundant proportion of sulphur, (indeed so much as to render it impracticable on that account to smelt them) they adopted the following process:—

They first burnt the ores, in which operation they separated the sulphur from them,—preserved the sulphur in sufficient quantities to defray the expence of the whole process,—then exposed the residuum to the rain, and to streams of water, and received and secured the water re-issuing from the heap of ores (and consequently impregnated with the copper) into pits and reservoirs contrived for the purpose: into these receptacles they then threw fragments of old iron, which immediately attracting the acid by which the copper had been floated from the heaps into the receptacles, and separating that acid from the copper; the copper, thus deprived of the power that sustained it, precipitated to the bottom. By this process the greatest part of the copper was extracted from the heaps of calcined ore, without expence: for what remained in them, they either burnt the ore over again alone, or added it to rich ores, which they found in small quantities, and smelted both together according to the common mode. These advantages enabled the Anglesea miners to undersell the Cornish.

The

The rivalry, however, continued 'till the year 1785, by which time the markets were full, the Cornish copper lay on hand, and a great alarm took place among the miners of that county. They called many meetings, to deliberate on their situation, and consider what was best to be done. At length, viz. in September 1785, some gentlemen perceiving and concluding that the Cornish adventures could not exist on the price to which copper was reduced, voluntarily came forward, formed themselves into a Company, called THE CORNISH METAL COMPANY, and agreed with the greater part of the miners to purchase from them all the copper then on hand, as well as all that should be produced by the mines of Cornwall for seven years from that time, at an advanced price.

This Company (having now possessed themselves of nearly all the copper raised in Cornwall, secured all that should be produced for seven years to come, and persuaded their countrymen, the Cornish copper miners, that the ores of Anglesea were inexhaustible, as well as to be wrought with scarcely any expence) entered into stipulations with the Anglesea Company, for the purpose of raising the price of copper, and for selling each in proportion to the quantities raised. The latter, however, being not only a company of practical miners, but also a company of copper merchants, outshined the former in this contract: other treaties and contracts succeeded; but the Cornish men were, in every instance, so far outgeneraled by the Anglesea party, that the latter, at length, completely monopolized all the copper in the kingdom, and *then* managed the markets as they pleased.

About this time Doctor WATSON published the fourth volume of his Chemical Essays: treating of the process of brass-making, he concludes thus: " The trade of brass-making has, within these few months, " been much deranged throughout the nation, by an agreement which " has been entered into by some of the principal Copper Companies, to " the exclusion of others, to buy up all the copper of the mines now " at work in the kingdom. *The effect of this plan is not yet either generally felt or foreseen.*"

Had the brass-makers taken the hint given in this remark, and petitioned for some legal restraints of this heavy monopoly, the difficulties they have already been thrown into, and are likely in a greater degree to suffer, might have been prevented. But from their neglecting such a step, these deep schemers ruined every copper-smelter, of small capital, that did not comply with their terms; managed the brass-makers as they pleased; exported their copper to every part of the world; pushed it, either by corruption or by main force, into naval architecture; raised its price from between fifty and sixty to one hundred and twenty pounds per ton; and, exclusively, received all the benefit of this enormous advance. In consequence, a few obscure individuals have acquired immense fortunes, to the great injury of the Copper Manufacturers in general, with very little advantage to the adventurers or labourers in mines, and none whatever to the public revenue. And this very Company, thus let loose upon the common-wealth, is now importing copper ores from Ireland, Germany, Turkey, or any other part of the world

world in which they can procure them; buying up all the old copper pots, bell-metal skillets, &c. &c. that they can lay their hands on; nay, even *light halfpence and farthings*,* to melt into sheathing and bolts for ships, &c.

The last contract between the Anglesea and the Cornish Companies expired in September last, when the Cornish Metal Company ceased.

The Cornish Metal Company appear to have acted from impulses of real patriotism: they resisted the monopoly, by paying their countrymen, the miners, so high a price for the copper raised in Cornwall, that they lost not only the interest of the money advanced, to establish the Company, but, as I am informed, a considerable part of the principal; while the greedy monopolizers, their antagonists, were rolling in all the luxuries that could result from monstrous wealth, or that could be enjoyed with the consciousness of extensive oppression and general inutility.

Some time before the last treaty between these Companies expired, a rumour was industriously sent abroad, that a new bed of copper ore had been discovered in Anglesea, which ran through the whole island,

* At Raifborough, about twenty miles up the river from London, is one of the Copper-Works of this Company. It could not but gratify the curious to visit a place where he may see, (*i. e. provided they will let him*) among other *phænomena*, a warehouse, half as big as St. Paul's church, filled with *light halfpence and farthings*. "We know not whence they came, nor whither they will go."

and

and was of such prodigious magnitude and richness, that it would be impossible ever to exhaust it. Boats, ships, bridges, houses,—nay, the faces of the earth and sea,—were to be covered with it. Soon, however, new overtures for new contracts were made; but the bait did not take:—Some of the Cornish men *suspected*.

They artfully contrived to get some of their most experienced labouring miners, to work in the Paris-mountain mine, for the purpose of discovering her situation and circumstances; and, strange as it may appear, that such an event should have happened, without its being publicly known, these men returned with a report, that “*the Paris-mountain mine WAS EXHAUSTED.*” The Anglesea Company denied the fact; which of them is right, it is not in my power to decide; but as the maintenance and prosperity of so many thousands depend upon the success of our mines, and the *constant* and *regular* supply of copper, it is a pity that the fact is not ascertained.

I have taken some trouble to get the best information I could on the state of this mine, as well as all others now working in the kingdom; and, be that information right or wrong, I shall make no apology for communicating it as I had it: if it be right, well; if wrong, let those who can give better information, give it.

I learn then that the Paris-mountain mine is not exhausted of ores, but that she is, as the miners term it, “*grown poor.*” The ore was, comparatively

comparatively speaking, never "*rich*." Some of the mines of Cornwall produce ores, about six tons of which make a ton of copper; and some even more than this. Indeed it is sometimes taken up purely metalline; but ores, seven tons of which produce a ton of copper, are esteemed "*rich ores*." Formerly, on the average, eight tons of Cornish ore have produced a ton of copper; but, since the mines are sunk deep, it takes ten or twelve. When we first heard of the Paris-mountain mine, about *fifteen* tons of her ore made a ton of copper. I was informed, not long since, by some of their smelters, that, to produce a ton of copper, above *five and thirty* tons were necessary of their *best* ore; such as they extract the metal from by smelting only, without the operation of burning, precipitation, &c. I have also been told, by some of the labouring miners who have worked in the mine, that the Anglesea Company were lowering their wages so fast, that they could scarcely subsist on their pay; that the ore, if it continued, as it had been long doing, to grow poorer and poorer, in a short time would not be worth raising; and that a great part of the mine is fallen in: and, it seems, the Company do not think it worth the expence of clearing away the rubbish.

So much for the Paris-mountain mine. Now let us take a view of the present state of the Cornish mines.

The principal mines now at work in Cornwall, from their having been pursued in the manner I have mentioned, are very deep and
over-

overflowed with water, which cannot be drawn without steam-engines, at an immense expence; and, I believe, it will not be too much to affirm, that to the ingenious Mr. WATT, of Birmingham, the inventor of the modern steam-engine, the nation is indebted for the great wealth, of which the Cornish mines have for many years been the sources. But these engines consume immense quantities of coals, the price of which, as there are no coal-mines either in that county or Devonshire, is always very high; frequently (after the drawback allowed by Act of Parliament for coals consumed in the mining of Cornwall) one pound five shillings per chaldron.* The quantity consumed, to work an engine, is increased in proportion to the required power, and consequent magnitude, of the engine, which depends on the depth of the mine and consequent additional weight of water to be drawn. The mines, which are now so deep, are daily growing deeper, and of course require more power to relieve them from the water; so that, it is much to be dreaded, great as this mechanical power is, the time may soon arrive when it will be found inadequate to these purposes, in some of the richest mines.

The north-west parishes, viz. Redruth, Gwennap, St. Agnes, Illugan, Camborne, Crowan, Gwinear, Phillack, St. Hilary, and a few others, describe that portion of the county in which copper, in any consider-

* Some of these engines will consume from three to four thousand pounds worth of coals per annum each.

able quantity, has been yet generally found; and, in those parishes, so many mines, within these few years, have been discontinued from their great depth and weight of water constantly drowning them, that a vast number of shells of steam-engines, erected for the purpose of drawing up water, at present stand useless on the northern road between Truro and Penzance.

I have been disappointed in my endeavours to procure an exact state of the annual products of the Cornish copper-mines for the last five years, but I believe it is about fifty-five thousand tons of ore, which produces about four thousand five hundred tons of pure copper, and, at the present price of copper, about four hundred and fifty thousand pounds per annum.

The parish of Gwenap has for many years produced the greatest quantity of copper ore of any of the mining parishes, and still continues to do so.

In this parish lie the mines, called the *Consolidated Mines*, being several mines united, viz. Wheal-Virgin, Poldice, Ale and Cakes, &c. carried on by a wealthy and spirited company of Cornish gentlemen. I have been told that they have been lately computed to produce near thirty thousand tons of ore per annum; yet, from their great depth, the costs of working them are so heavy, that they have lately amounted to a considerable sum more than the income: and that they would

have stopped some time ago, had not the Lords of the soil given up half their dues. These mines are nearly two hundred fathoms deep, and must stop in less than two years, even at the present price of copper; and should the war, which at present threatens us, take place, the depreciation that will consequently attach for a short time to this, as well as every other article of trade, will effect their discontinuance immediately.

The parish of Redruth has been long very productive of copper: the North-Downs mine, situate in this parish, is second in production to the Consolidated Mines, and has produced above twelve thousand tons of ore per annum; but she is now above one hundred and fifty fathoms deep, is excessively laden with water, has four steam-engines, and, it is supposed, cannot continue long, as she now barely pays her costs.*

In the parish of *Camborne* there have been two mines, *Wbeal-Gons* and *Stray-Park*, very productive for many years, but these mines are now one hundred and eighty odd fathoms deep; and, as it is presumed that no mine can pay her costs whose depth exceeds two hundred fathoms, these mines, supposing they sink only six fathoms a year, must stop in three years.

* There are several other mines putting on in this parish, and, it is to be hoped, they will be attended with success.

In the parish of Crowan, the Crenver mine, and Wheal-Treasure, are the only mines of consequence. The former has produced about three hundred and fifty tons of ore per month; she is now about one hundred and forty fathoms deep, and the water is so quick upon her, that it is supposed she cannot stand ten fathoms longer, so that she may stop in less than two years; but Wheal-Treasure is wrought with one steam-engine, and is about one hundred fathoms deep, is very productive, and, it is thought, will continue to be so for many years.

The Duke of Devonshire had a rich copper mine in Derbyshire, which made some noise, but it is now of no value; and the other mines of the kingdom are, in their present circumstances, scarcely worth mentioning.

Thus it appears probable, that the mines which produce three-fourths of all the copper now raised in the kingdom will, in less than three years, cease to produce any; and, should such an event happen, without proper steps being taken to provide for the miners and manufacturers, who, depending on these adventures, must then be thrown out of employ, the consequences may be very calamitous. It cannot be amiss, therefore, either to anticipate as many of these consequences as we can, or to offer any reasonable considerations that may possibly tend to avert them:—In order to this, it will be necessary, in the next place, to take

A CONCISE VIEW OF THE RISE, PROGRESS, AND PRESENT STATE
OF METALLURGY IN ENGLAND.

THE rise of metallic manufactures in England may, perhaps, be referred to the reign of Richard the Third. In this reign England was in a very miserable situation. The number of her inhabitants had been diminishing for the last one hundred years. The disputes with the Scotch; the conquests made in France, with the means necessary for preserving them; and the civil wars which had so desperately raged at home; had, during the reigns of the three last Henrys, and Edward the Fourth, all conspired to lay waste, depopulate, and derange the country in almost every point of view. When Richard came to the throne, improvements of every kind had ceased; the spirit of cultivation was lost, and the most essential concerns of the country were in confusion.

The wretched state to which the subjects of Richard, by this train of unfortunate causes, were reduced, would soon have driven those who survived it to seek bread in distant countries, had not some remedies been suggested to lessen the pressure of inconvenience under which they laboured. The baser kinds of tenure were remitted; villenage
grew

grew into difuse; and the labours of *freemen* soon began to shew the superior benefits arising to a state from the *bleffings of liberty*; agriculture, manufacture, and trade, began to employ the people; and Richard, perceiving the advantages likely to be derived from the industry of his subjects, entered into various negotiations with foreign princes, for encouraging and promoting these views; and companies, for the management of English commerce, were established in different parts of the world.

This gave encouragement to new undertakings; and incorporations of companies, to carry on different manufactures, took place, which were increased and improved from the mutual support and exertions of their members. The value of our native commodities, and the encouragement thus given to the manufacture of them, invited numerous ingenious foreigners, from all parts, to our shores, whose various efforts united,—to improve the elements of our knowledge, to multiply our manufactures, increase our trade, extend our commerce and navigation; and, by initiating numbers of people into different employments, and by that means giving new sustenance to the poor, *promoting population*, and improving and increasing the landed property,—raised a spirit of general improvement.

Henry VII. whose judicious, though severe, reign was comprehensively beneficial to his subjects, encouraged the manufactures of the kingdom in general; and perceiving the absurdity of keeping, by the
expense

expencc and ravage of war, an ideal territory, which, even in peace, could be of no substantial benefit to him, wisely compromised with the French king for his claim on that crown, and entered into a number of equally wise treaties with other powers, which gave new vigour and efficacy to English industry. Henry VIIIth, in these respects, followed in a great degree the example of his father. In his reign, as well as in that of his son Edward VIth, our metallic manufactures, which had been thus encouraged, began to exhibit their national importance, and several Acts of Parliament* were passed, *prohibiting the exportation of brass, copper, latten,† bell-metal, pan-metal, gun-metal, and shroff-metal*. But the glorious reign of Queen Elizabeth is the æra at which historians most unanimously commence their examination of the rise of that extensive commerce which we have now so long enjoyed. Before this, our foreign commerce consisted mostly in the exportation of the productions of our island in their natural state; such as tin, lead, iron, hides, wool, and fish. But the policy of Elizabeth, and of her wise ministers, directed her views towards the population and improvement of her state; which, she perceived, could only be effected by inviting foreigners to come among her subjects, to instruct them in the *manufacture* of those productions. Foreign artisans

* 8 Hen. VIII. c. 7, 10, 33. 2 & 3 Edw. VI. c. 37.

† I do not know what was meant by latten at this time; the Devonshire and Cornish people now call tin-plate by the name of latten, which was first brought to England by the adventurous patriot Andrew Yarranton.

and manufacturers were accordingly invited into the kingdom, and were invested with all the advantages enjoyed by native subjects.

These wise and judicious views of Elizabeth were forwarded by the folly of a rival sovereign. The tyranny of the Spanish governor of the Netherlands (Duke D'Alva) drove a number of Walloons and Flemings into England, who were skilled in the manufactures of our staple commodities, *wool* and *metals*.

This was a great event; and so kindly received were those refugees by Elizabeth, and they attended so strictly to the manufactures in which they were skilful, that the woollen manufacture, in all its branches, was soon carried to great perfection.

Among these refugees was one Christopher Schutz, a German metallurgist, of great skill, to whom, with William Humphry her assayer-master, Queen Elizabeth, in 1567, granted all the calamine in England, and within the English pale in Ireland: these gentlemen, in 1568, formed a company, composed of some of the first noblemen and gentlemen in the kingdom,* to carry on the manufactory of brass. This, as brass is the basis of our yellow-metal wares, appears to be the first spirited step towards the perfection of our metallic manufactures.

* Sir Nicholas Bacon, the Duke of Norfolk, the Earl of Pembroke and Leicester, Lord Cobham, and others.

So swift is the progress of art, under public encouragement and protection, that by the year 1639, an æra by no means auspicious to enterprizes in trade, we had a sufficiency of brass wire (an article to that period supplied by foreign nations) for all our purposes; and the future importation of it was in that year prohibited by royal proclamation.

About 1650, it is said, upwards of ten thousand men were employed in the brass manufactories in England.*

In the reign of William and Mary, copper became so plentiful, that that the Acts of Henry VIII. and Edward VI. [see p. 30] were partially repealed; and it was made lawful to export all manner of iron, copper, and mundic-metal.† This step appears to have been an impolitic excess: it was turning away a whole river merely to abate a casual overflowing. In ten years (in the reign of Queen Anne) the brass-works were quite decayed, from the too lavish exportation of crude copper, under this supposed indulgence, and the scarcity and dearth consequent to that exportation.

* The consumption of copper in those manufactories of brass at length encouraged the spirit of mining; and it was found, that copper, for which we had been before beholden to foreigners, was soon to be had in sufficient quantities from the Mendip and other British mines, now discontinued, and of no importance.

† By "Mundic-metal" is to be understood, the beautiful mineral commonly called *Marsasite*; it is not metallic, but a composition of sulphur and arsenic.

In

In 1708, a memorial was presented to the House of Commons, setting forth several reasons for encouraging copper mines, and continuing the brass manufactory in England, and for these purposes praying the interposition of Parliament. In the same year an act was passed, by which some duties, which had formerly been laid on the exportation of copper and brass wire, were taken off, and *these* articles allowed to be exported duty-free.

This, in some degree, revived the brass manufactory; the demands made for copper by the brass-makers, and the metallic manufacturers at Birmingham, who were now become very numerous, urged on the spirit of mining in the manner already described.

In 1783, the brass-makers were become again very numerous, and in that year *they* applied to Parliament for a liberty, similar to that which had been granted to the iron and copper smelters, viz. to export crude brass. The bill passed the House of Commons; but, fortunately for the state, the Birmingham manufacturers presented a petition to Parliament, stating that the effects of such a bill would ruin their manufactures, which, as they afforded employment to thousands of people, were of the utmost consequence to the kingdom in general; and the bill was accordingly thrown out by the Lords. Had this bill been carried into a law, the mischiefs arising from it, before they could have been remedied, would have produced the most dreadful consequences.

The brass-makers may now urge reasons against the exportation of copper, stronger than those alledged by the Birmingham manufacturers, at that period, against the exportation of brass; for the brass-makers of Bristol, Macclesfield, Warrington, and other parts of England, to perfect their article for the manufacturers, lately employed upwards of fifty thousand people; yet they are prevented from turning it to the best advantage, lest it should be the means of taking employment from *more*,—that is to say, from the *manufacturers*: yet copper, without which brass cannot be made, and which, as I have before stated, and which I shall by and by shew, is the basis, not only of brass, but of all our valuable yellow-mixed metals; by the manufacture of which many hundreds of thousands of people are maintained, and the state is enriched, and in a great degree supported; yet this grand pillar, this very essence of the trade, is suffered, as soon as it is dug out of the earth, to be sent out of the country, without any sort of restriction whatsoever, and consumed and wasted in the most gross manner, and in all the destructive modes of consumption that imagination can suggest.

The success of the trade of metal-workers in England does not depend upon the certainty of procuring *brass*, but of procuring *divers qualities* of brass, and that too of the English manufacture; for it is by the mixture of these commodities, in various ways, known only to the manufacturers themselves, that our metallic articles are brought to such perfection as to find markets in foreign countries in preference to manufactures of similar articles by other Europeans.

“ Great

“ Great quantities of good brafs,” fays Doctor WATSON,* “ are
 “ made by moft nations in Europe, as well as by the Englifh; but the
 “ Englifh brafs is more adapted to the Birmingham manufactories than
 “ any other fort is; and hence, in FRANCE, PORTUGAL, RUSSIA, and
 “ GERMANY, our *unmanufactured* brafs is allowed to be imported *free of*
 “ *duty*; but heavy duties are laid in thofe countries on *manufactured* brafs,
 “ when imported. The manner of mixing different forts of brafs, fo as
 “ to make the mixture fit for particular manufactures, is not known to
 “ foreigners, though this is a circumftance of the greateft importance;
 “ but there can be little doubt, that if foreign nations were poffeffed of
 “ all the forts of Englifh brafs, they would foon feduce our workmen to
 “ instruct them in the manner of mixing them, and in fome other cir-
 “ cumftances which are not generally known, but on which the fuccefs
 “ of the manufacture depends in a great degree.”

Now, though foreigners cannot, merely by the exportation of cop-
 per, acquire all the methods of making and mixing the different forts
 of Englifh brafs; yet, as copper is the bafis of brafs, a fcarcity of cop-
 per muft produce a fcarcity of brafs; and a fcarcity of brafs, a fcarcity
 of other metals compounded of it: thefe circumftances will, nay, at
 prefent do, throw difficulties in the way of brafs-makers and manufac-
 turers of metallic wares; and the manufacturers, as well of the one
 branch as the other, muft and do now want employment. The confe-
 quence of this, if not already the cafe, will foon be, that our brafs-

* Vol. iv. p. 41.

makers, metal-workers, and metallic artizans in general, will get into other countries, and instruct their manufacturers in all the ways of making brafs used in England, and in the various modes of mixing this metal in our manufactures, which render them so superior; and, as copper and calamine, of which brafs is made, are produced elsewhere as plentifully as here, such an event (which, if the French establish a free government, is not unlikely to happen soon, unless some most effectual steps be taken to prevent it) cannot but effect a ruinous competition with our metallic manufactures, and render England no longer the staple of these commodities.

As I have stated that copper is the basis of our most valuable mixed metals, it may not be unnecessary to illustrate the assertion by the following table.

A TABLE OF THE DIFFERENT PROPORTIONS OF COPPER, IN THE COMPOSITION OF OUR MOST VALUABLE MIXED METALS.

BRASS.—One pound of copper, and about nineteen ounces of calamine, produce one pound and a half of brafs.

				Parts Copper.	Parts Tin, Zinc, or Lead.
GUN-METAL is compounded of	—	—		10	1
POT-METAL*	—	—	—	33	1 OF 2
SPECULUM METAL	—	—	—	3	2
BELL METAL	—	—	—	8	1
PINCHBECKS, &c.	—	—	—	12	1

* The use of lead, I apprehend, is discontinued in this compound.

Thus

Thus the reader will see that all our yellow-mixed metals together contain 66 parts copper, and 6 or 7 parts tin, zinc, or lead.

From this statement we see that seven-eighths of copper enter into all the yellow metallic compositions which I have set down in the table; and, from these and various admixtures of them, many hundreds of thousands of people in England are constantly employed in converting them into all sorts of articles of utility and ornament for home consumption and foreign trade; all of whom (should copper, in Great-Britain, become so dear and scarce, that foreigners should undersell us in metallic manufacture) must want bread, or emigrate in search of it: and if the report of the Cornish miners be true, and the Paris-mountain mine, (which has so long been computed to produce from two to three thousand tons of pure copper annually) and likewise the Consolidated and other deep mines of Cornwall, which have produced upwards of four thousand tons a year, should, from the causes I have suggested, cease to produce any, it is impossible to guess to what losses and disadvantages we shall be exposed; for even as it is, from the increase of population and manufacture, and from the present unrestrained and wasteful applications of copper, there is a greater demand for it than can be supplied by our own mines; and as it seems, that, in the present state and course of things, these misfortunes must be near at hand, the situation of the metallic manufacturers demands immediate attention and effectual relief: how that relief may be rendered I shall next consider.

A PLAN

A PLAN FOR RELIEVING THE BRASS-MAKERS, AND OTHER
METALLIC MANUFACTURERS.

IN order to effect an immediate and effectual relief, and secure a permanent prosperity to the manufacturers of brass and other metallic wares, it seems to me, that there are three things especially necessary. 1st. If not for a while entirely to prohibit the exportation of copper, yet certainly to regulate it by proper limitations and restrictions, and to take off a tax or duty of ten pounds per ton imposed on the importation of it into England from other countries. 2^{dly}. To open more mines for its production. And 3^{dly}. (and paramount to every other consideration) To abolish its use in various consuming and pernicious purposes, to which it is at present misapplied.—I shall treat each of these heads in its turn; and first,

ON THE EXPORTATION OF COPPER.

AFTER what has been said on the state of *copper* mines, and the number of persons that depend on their productions, I think it would be superfluous to use any further arguments to induce a Parliamentary regulation of the exportation of this article, or to shew the consequences which must ensue if it be neglected.

I cannot,

I cannot, however, help remarking, that it is strange that the *exportation of wool*, of which there is a regular annual supply, *without any contingency*, should be prohibited under pain of death; and that copper, the production of which is *intirely contingent*, should be left to the mercy of monopolizers, without a single law to protect it.

Mines may be considered as somewhat of the nature of State-Lotteries: though there may be many blanks to a prize, and many of the individuals, induced to adventure in these contingencies, may consequently be losers; yet it is a fair presumption that nobody adventures who cannot afford a risque, and the *State* is, at all events, infallibly a gainer—in this case, a gainer of so much mining produce, risen from its own lands, by the labour of its own inhabitants, and brought in and added to the national stock of materials for manufacture and commerce, without sending a shilling out of the country! Mining, therefore, is not only to be tolerated, but encouraged without reserve, and in no case to be checked, but when necessary, in order to preserve or restore the necessary and just balance of our trade in general. I shall suggest a hint or two, by which the proposed regulations of the exportation of copper may be governed.

The object to be aimed at is this:—The article should be authoritatively kept as near to a certain price as possible; and, in ascertaining such price, retrospect should be had to the price of it in other parts of the world; and, at the same time, the two following material objects
must

must be attended to at home: the price must be kept high enough to pay the miner handsomely for raising the ores; and, at the same time, it should be so low that our manufacturers may buy it cheap enough to enable the merchant to undersell the foreign manufacturers of similar wares. I apprehend that the brass-makers can afford to give ninety or ninety-five pounds per ton; and I think that somewhere between these sums may be the standard; this appears to me to be a good price, and fair for the miner, the manufacturer, and the merchant.

The exportation then should be stopped, and the duty I have mentioned, as payable on its importation, should be taken off, 'till it is reduced to somewhere about these prices.*

It may be objected, that if the price of copper be reduced but five pounds per ton, the Consolidated Mines, with some others in Cornwall, that I have mentioned as but barely capable of paying their costs, must stop immediately on such a reduction; and that, in such case, the

* I apprehend that copper cannot be imported into England, from any foreign country, under one hundred and twelve pounds per ton; and I see no mischief that can arise from the duty of twelve pounds per ton being taken off, as it will then be between five and ten pounds per ton more than the brass-makers can afford to give for it. And if there should be at any time a surplus, after our manufacturers are supplied, the India Company can always afford to give ninety-five pounds per ton for it; and there may be an article in the new charter by which they may be bound to take all the superfluous copper as well as tin, after the manufacturers are supplied.

manufacturers

manufacturers will get no copper at all. My answer is: So trifling is the quantity of ore now lying on the mines, or at the smelting-houses; so trifling the unmanufactured copper in the kingdom, and so great the demand of our manufacturers for this article; that, independently of the consideration of approaching war, were the ports to be shut on it to-morrow, there would be no chance of the price falling very considerably in less than two or three years; by which time these mines, unless some new contrivances are hit upon to bring the ores to *grafs** at a much less expence than at present, must stop, of necessity, at the present high price; so that such an argument would be futile; and, I think, I may venture to say, that if the manufacturers tamely wait to see these mines go down, without some steps being taken to provide for their loss, copper will, instead of getting cheaper, double its present price, which will destroy the manufactures; and what will copper be worth then?—These considerations lead me, secondly, to consider

OF OPENING NEW MINES FOR THE PRODUCTION OF COPPER.

IT seems that the demands made for copper, by our metal-workers, are now so constant and great, that barely restricting the exportation of this article may, perhaps, be insufficient to satisfy them; it there-

* A mining term for bringing the ores out of the mine and laying them on the ground or *grafs*.

fore appears, that every possible encouragement should be given to adventurers to open new mines for the discovery and production of this metal.

Though, with respect to absolute certainty of success, mining is (as has been before admitted) a sort of lottery or gambling, yet it is very far indeed from being the worst of its species; because, among other favourable differences, success in them does not, as in a lottery, depend wholly on chance: the long experience and observation of miners, collectively, have enabled them to judge, by certain symptoms and tokens easily come at, whether an adventure be worth pursuing or not; and consequently, when these symptoms and tokens induce them to go on, they are not so often disappointed in their expectations now as formerly. This may be considered as the rudiment of an important branch of science, which, it seems possible, further experiment and observation may so amplify, as, by leaving still less to chance, and more to knowledge and industry, to constitute a still more solid ground of encouragement. With respect to the *public* interest on this point, it is also to be considered, that, in a general view, the losses in mining are to those whose opulence can bear it; that the money sunk is not annihilated, but goes chiefly to maintain and preserve the poor labourer, artisan, and manufacturer, who could not subsist without it. Neither these considerations, however, nor any others, should induce individuals of small capital, or companies who cannot afford to lay out of their money for five or ten years, to think of engaging in what are
called

called seeking adventures; or to have any thing to do with mining, unless it be to carry on mines already discovered.

The formation of *wealthy* companies, for these purposes, is therefore highly eligible and desirable.

I apprehend that some such are forming in London and Birmingham; and, on a general view, it cannot be doubted, that they will be rewarded with success proportioned to their spirit.

Mining is so very material to the interests of this state, that if a *bounty* were given by government, of so much per fathom, to men who would drive adits, under hills to be fixed upon by intelligent miners, it might operate as an encouragement to labouring miners to do this when they have no other employment, which sometimes happens; and would embolden the timid to pursue such concerns with more zeal: or, if government were to bear some proportion of the expence of such enterprizes with other adventurers, it might answer very beneficial purposes.

When mines have been discovered in hills, it has long been the practice to go to the foot of the hill, and drive an adit from thence to the mine, for the purpose of relieving her of her water; and it has frequently happened, that in driving those adits, the miners, by the way, have discovered lodes more valuable than those of the mines to which

they were directing their level. And *there are instances (though not so frequent perhaps as could be wished)* ~~it has since been a practice, (though not so much followed as, perhaps, it ought to be)~~ where miners, from the circumstance of former mines having been wrought and discontinued, or where the ground has exhibited symptoms of fertility in ore, have been induced to think there was a prospect of success to drive levels for the very purpose of discovery, without directing the experiment to any particular mine; and many of those, by patience and perseverance, have amply rewarded the enterprize.

The late ingenious Doctor WILLIAM PRICE, of Redruth, treating of this topic, says, "I must allow that such adventures are very laudable; for if a level forms an horizontal acute angle, with the perpendicular section of the summit of an hill, at the charge of three thousand pounds in fifteen years driving, though without the success desired, it is likely to prove an useful undertaking for posterity, who may reap the advantage of it, when they want levels to unwater veins that may be discovered in other parts of the hill. The expence of an adit is flow and small, therefore it is easily borne. Two or three hundred pounds a year, in driving an adit, is scarcely felt by eight or ten persons, than whom seldom fewer are concerned; and this too upon the chance of finding a vein or veins, that may throw up an amazing profit presently after discovery, by an advantage in the very means of discovery itself."

It would be material encouragement to mining to remit every tax and duty to government, with which the pursuit of that business still

remains clogged. It may be objected that the revenue will be diminished, *pro tanto*; and why should this branch of trade be so favoured more than others? The answer is, that the amount of the taxes on the articles consumed in mines, is far less than the amount of those resulting from the manufactures of their produce; and, that the burden of these taxes depresses the spirit of mine-adventuring so much as to cause a diminution of manufacture, and consequently of the duties on those manufactures, to a much greater amount than could possibly be lost by the proposed remission. Besides, that mining is a business of peculiar hazard and peril, and is not in its very nature a fair subject of taxation, because its value will not, as in the case of every other business, admit of any certain calculation; while it is infallibly certain, that if its produce cannot be brought to market, unless it can be rendered at a less price than that of foreign countries, it is taxed for mere inability and misfortune, which, being insupportable, must of course totally crush the whole trade.

It is very generally and reasonably believed, that but for the patriotic and strenuous perseverance of a late distinguished Senator, a native of and representative in parliament for this county, (the grandfather of the present benevolent and accomplished Sir JOHN ST. AUBYN, of Clowance) whose integrity was ~~the~~ superior to the corruptions of WALPOLE's and consequently of any other administration by which a remission of part of the duty on candles used in mining was effected, ~~and the~~ ~~the~~ the block-tin trade, which has since risen to such importance, would actually have sunk. It

It is a well-known fact too, that but for the drawback allowed by government of the duty paid on the coals consumed by steam-engines in the county of Cornwall, these wonderful machines would never have got into the general use they have been in, in that county: and as we are certainly indebted to these engines for the great progress that has been made in copper-mining in the last ten years, other drawbacks, equally reasonable and necessary, might and ought to be allowed, viz. on leather, gunpowder, pitch, ropes, hemp, and in general (as has been already presumed) every taxed article that is consumed in mines. If encouragements like these should immediately be applied for and granted, the great mines I have mentioned as being in danger of stopping may be enabled to continue some years longer, perhaps 'till new mines are got into a course of work sufficient to supply their loss; for I cannot mean to insinuate, that the mines of Cornwall are exhausted; on the contrary, I am convinced that copper mining is in its infancy; and firmly believe that the county of Cornwall, under the encouragement I have suggested, will continue for ages a source of riches to those who have property and spirit to speculate deeply in mining; though, as I have said before, and cannot help repeating, it will not do for people of slender fortunes, or companies with small capitals; or under monopolies; or without liberal incentives or encouragements from government or otherwise.

With respect to individual exertion, and encouragements to exertion, if a tontine were set on foot, for raising a large sum of money, to be vested

vested in some public fund, for the purpose of discovering and working mines, the capital and profits to be divided among the survivors of the subscribers at the end of seven, fourteen, or twenty-one years, it might be attended with success, and when maturely considered, seems a very eligible mode of providing for younger children.

I shall now beg permission to intimate such observations as have occurred to me respecting those particular places in the county of Cornwall that I have thought most eligible for immediate adventures in copper-mining. There are many old mines in Cornwall known to have been rich, and to have been discontinued at only seventy or eighty fathoms depth, on account of the water, which could not be extracted beyond that depth before Mr. WATT'S steam-engine was in use.

These mines might, perhaps, be brought into a good course of working in two or three years, and the lords of the soil would be glad enough to have them set to work.

The manufacturers of Birmingham,* feeling the necessity of working new mines, have formed a company among themselves, which I was told, six or eight months ago, could and would adventure two or three hundred thousand pounds. They have taken very considerable sets of

* How far it may be politic for Cornish-men to suffer manufacturers to turn miners, I shall leave them to determine.

mining ground in Cornwall, have opened a-new several old mines; and, from the spirited manner in which these adventures began, it seemed likely that they would soon be productive. It is much to be wished that the report of their having been impeded, and some of them entirely defeated by the late violent check upon credit, may be unfounded.

These adventurers have taken, among others, two old mines in ST. HILARY, called *Hallamining* and *Retallack*. These mines have been very productive, but stopped about ten years ago, at the depth only of about eighty fathoms. Steam-engines are erecting on them, and it is thought they may be brought into a course of working in a few years.

They have also taken a set of a large mine, called the *Manor Mine*, in the parish of *Gwinear*, which they have been working with great spirit, and it was said to be promising.

They have purchased, I believe, a great part of a mine from the Rev. THOMAS WILLS, of Helston, called *Camborne Vein Mine*. This mine lies adjoining, on the west, to Wheal-Gons and Stray-Park, mines which I have already mentioned to have been very productive, and as it possesses all the veins of these mines, it may reasonably be expected to be productive, if wrought with spirit.

The parish of Illugan has been long discovered to be fertile in copper, and is emphatically the ground for mining. The most profitable
mine

mine now at work in Cornwall, or perhaps in the kingdom, is Cook's Kitchen in this parish: she produces about three hundred and fifty tons of ore per month; and though nearly one hundred and fifty fathoms deep, is relieved of her water by two water engines, at a very small expence. She has five veins of exceedingly rich ore, has been computed to produce fifteen thousand pounds a year profit to the adventurers for the last six years; and this last Michaelmas quarter she netted six thousand pounds, besides the Lord's dues, which are one-sixth, clear, of all the ores raised.

This mine is in the land of Sir FRANCIS BASSET, bart.; who, as lord of the soil, and an adventurer, is supposed to receive from her alone near ten thousand pounds per annum.

Adjoining this, on the east, in the land of — HUNT, esq; is a mine called Tin Croft, which contains all the lodes of Cook's Kitchen; has been wrought about a year and half, and promises to be equally good.

East of Tin Croft, Sir FRANCIS BASSET's land adjoins again, and runs for upwards of a mile and half, on the lodes of Cook's Kitchen and Tin Croft.

It is well known that the lodes in this land are remarkably rich, for Sir FRANCIS BASSET's father had a mine in it called Tregajoran Mine,

from which he was supposed to have received fifty thousand pounds: she was stopped at no considerable depth, on account of the difficulty of drawing off her water. There is now an adit driving from Cook's Kitchen deep adit through Tin Croft, into this land, which may be ~~brought in~~ ^{completed} in about four or five years, and will nearly unwater Tregajoran mine, and render her again very valuable.

It is generally believed, that most of the hills in all this part of Cornwall are possessed of copper. Concerning this metal then, our present greatest objects are to promote *produce*, and to regulate *application*.

From the theory of copper-mining, it seems, that, generally speaking, it takes eight or ten years *at least* to bring a mine into a good steady course of working; and, supposing that the Consolidated, and other great mines which I have mentioned, exist no longer than three years, the most strenuous exertions may be inadequate to the production of a sufficient quantity of copper to keep alive the manufactures in which it is used; and even supposing that there is a certainty (which, by the bye, to a *certainty* there is not) of finding the mines, which I have mentioned to be now setting to work, very productive; or of discovering others equally so, then there must be at least a lapse of five or six years between the discontinuance of these great mines now at work, and the period of production in the new ones: so that it seems both the proposed means in combination, (*viz.* Restraining the exportation of copper,

per, and opening new mines) though carried immediately into effect, will be inadequate to supply the demands of the manufactories.— I am therefore led, thirdly, to

STRICTURES ON THE APPLICATION OF COPPER TO VARIOUS IMPROPER, WASTEFUL, AND PERNICIOUS PURPOSES; AND TO ARGUMENTS FOR THE NECESSITY OF REFORMING SUCH ABUSES.

IN the beginning of this work, I attempted some elucidation of the œconomy of metals, from their natural state to the finished manufacture; and, I presume, it will be found, that the œconomy of the use of copper is an object highly worthy of attention. It has been observed, that a pound of copper, the intrinsic worth of which, in an unmanufactured state, does not exceed one shilling, is capable of receiving every degree of increase of that value up to five hundred times or more by manufacture; and it has been asserted, and I fear it is too severely felt by many, that the manufacturers, who are capable of giving it this additional value, cannot procure sufficient quantities of it to satisfy their demands, to the great distress of the industrious labourers in that branch of business, thereby thrown out of employ, and consequently to the injury of the commonwealth. I have pointed out some of the causes of this mischief; but others, of still greater extent, and still worse tendency, remain to be described. Our copper is

diminished by *wasteful* and *unnecessary* modes of consumption: its present universal misapplication in naval architecture (in the forms of sheathing, bolts, nails, rudder-works, and other metallic articles of ships) first claims attention: for the immediate correction of these abuses, the prosperity not only of our metallic manufacturers, but of our trade in general, and the very safety of our navy, call aloud.

Not less than one-half of the production of all our mines is now annually misused in naval architecture alone, and full one-half of that quantity is wasted in the sea every five years, by corrosion; to say nothing of what sinks into immediate and irretrievable perdition with the ships that are daily foundering. It is a melancholy truth too, that while the increasing price and extravagant consumption of copper are ruining our metal-workers, its application to naval purposes is eating out, endangering, and destroying, our navy as well as our merchant ships; consuming both public and private property, and rendering iron, which is the most plentiful, the cheapest, strongest, and (except tin) the lightest of all metals, and consequently the most fit to be used in ship-building, entirely useless for that purpose.

It is often and truly remarked, that the world is governed by *fashion*, and not by *reason*.

How far this opinion is verified in the practice of sheathing, bolting, &c. ships with copper, I leave those who read what I have to say on the subject to determine.

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As nothing but copper is now in use for these purposes, it may be fairly enquired by the merchant and the mariner, " If copper sheathing be abolished, how are the ships bottoms to be protected from the attacks of the worm and the barnacle?"

To answer this, let us take a brief review of ship-sheathing; see how it came about that copper is in use for that purpose; and (in conclusion) whether we cannot discover something that will answer the purpose as well, composed of more plentiful materials, furnished at a less expence, and which shall not merely be less mischievous to the interests of the manufactories depending on copper, but have a positive tendency to give the due support to those interests, and even produce a fresh subject for the exertions of labour and mechanical ingenuity.

THE HISTORY OF SHEATHING SHIPS.

WHEN we became acquainted with the nature of traffic, and perceived the advantages which might result from exporting, in our own ships, the valuable productions of our island; when our neighbours and the Eastern nations (from the utility of our commodities) began to court our acquaintance, and to treat us no longer as barbarians, and our commerce grew more universal; the improvement of naval architecture

teeture (on which the success of commerce so much depends) soon engaged our attention, and vessels, of various constructions, were built, to answer the various purposes of commercial navigation.*

When we began to trade to the Southern climates, and our ships of necessity got into fresh water, and lay upon the mud, the career of our navigation, in those parts, met with a check, which for a long time disconcerted our mariners; an insect, called the *teredo worm*, came out of the mud, and ate the ships bottoms full of holes, to the astonishment of the seamen, and to the very dangerous injury of the ships.

To remedy this evil was an important object, but could not for a long time be attained; boards, pitch, tar, rosin, brimstone, and a variety of other articles, were tried for covering or sheathing ships bottoms, to defeat the attacks of this worm; but nothing succeeded 'till about 1670, when Sir PHILIP HOWARD, and Major WATSON, stated to parliament, that, with great charge and industry, they had found out a new way, by means of an English manufacture, to preserve the hulls of ships from worms, &c. which was *much smoother*, and consequently better for sailing; *cheaper*, and more durable than any sheathing or graving there-

* “ Long slight ships for carrying masts, barks, &c.; and short strong ones for lead, iron, &c.; one sort to trade at ports where they need not lie aground; another sort where they must jump upon the sand twice every twelve hours; some for the Northern navigations, among ice; and some for the South, among worms, &c.”

Sir WILLIAM PETTY.

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tofore used. The legislature being satisfied, upon examination, of the great probable benefits of the invention, as an encouragement to those gentlemen to make their discovery public, was pleased to grant them an act of parliament, securing to them the sole property of their invention for fourteen years, with a prohibition to all other persons. This invention was *milled lead*.

About four years after, a Mr. BULTEEL gave an account of this sheathing in a paper published in the Philosophical Transactions, No. 100, p. 6193; in which he states, that experiments had been made on several of his Majesty's ships; and says, that the sheathing, after three years, was found to be in as good condition as at the first doing, and that the ships were so tight, during the whole time, that the sailors were obliged to heave in water to keep them sweet.

In 1691 (one and twenty years after the sheathing with lead was first practised) Sir WILLIAM PETTY published his "*Naval Philosophy, and the New Invention of Milled Lead for Sheathing of Ships*;" by which it appears, that about twenty ships belonging to the navy had been then sheathed with lead.

The officers of the navy, soon after this, began to make complaints against this sheathing; they represented, that though it answered the purpose of defending the ship from the worm better than any other sheathing theretofore used, and though ships sheathed with it would fail
faster

faster and better than unsheathed, or wood-sheathed ships; yet, that these advantages were more than counterbalanced, by the danger the ship was put in, by its use; for that it had so corroded and wasted the iron bolts, under water, and rudder irons, and in so short a time, as had never been observed in any unsheathed or wood-sheathed ships.

“ The persons interested in lead sheathing published a very sensible “ defence;” * but they could not contradict the fact, and *lead sheathing* was discontinued in the British navy, *on account of its destruction of the iron bolts and rudder irons.*

The navy and merchant ships were again exposed to the attacks of the worm, in the Southern climates, and to the barnacle; and the ship-builders again endeavoured to guard the ships from them by the application of tar, pitch, &c. but their endeavours were as fruitless as they had been before the use of lead. Afterwards one JOACHIM SMITH got a patent for a *glass composition*, or paste, for sheathing ships. After he had obtained the patent, he went to France, and clandestinely offered this *pastry* to that court, which being known in England, and at the same time his proceedings in England becoming known in France, his project, which, upon the very face of it appears to have been trivial and inefficacious, was scouted by both.

* WATSON.

Copper sheathing was next introduced, but it was soon found that the action of the copper, upon the iron bolts, nails, and rudder works of the ships, was so general and so terribly rapid, as to eat off the heads of the bolts and nails in so short a time, that many ships, almost new and apparently stout, fell in pieces upon a *strain*, or foundered suddenly at sea; and others, from the iron work of the rudders being decayed by the copper, and giving way, had lost their rudders, and perished from the impracticability of steering them.

So sensible and so great an evil could not but alarm all persons interested in the safety of the trade and navy of the empire; and it was almost determined, that copper sheathing should be discontinued in the British navy. The patrons of copper sheathing, however, opposed this determination with great vigour; and every experiment that imagination could suggest was tried to do away the objections; at length, an ingenious mechanic of Birmingham* suggested the idea of substituting copper bolts, nails, and rudder works, for iron ones; and constructed a mill for making them. The immense expence of this plan was an objection which the address and influence of the patrons of naval coppering soon removed; fallacious calculations (similar perhaps to some hereafter noticed) were obtruded upon the persons to whom these subjects are officially referred; copper was brought into general

* JOHN WESTWOOD; he took a patent for securing the exercise of his invention, and the "*Anglesea Copper-Company*" bought it of him for four thousand pounds.

use, not only in the navy, but (under that sanction, and with the powerful auxiliary *puffing*) in trading vessels of all descriptions: and the impressions thus made by these sophistical calculations, not having been hitherto detected, seem still to retain their original delusory force: that they were fallacious and delusory, is not merely apprehended, but will be carefully demonstrated in the course of this work.

When the custom of sheathing with copper was introduced among the merchant ships, the sheets were about thirteen or fourteen ounces to the foot, and copper was about six-pence halfpenny or seven-pence per pound. It gradually increased to sixteen ounces to the foot; and a short time ago the Anglesea Company increased their sheathing from sixteen to twenty-four ounces to the foot; and with the increase of weight they increased the price, and warranted their sheathing to stand five years.

It happened that this copper stood but little longer than that which had been used before, and the Company were obliged, in about two years, to lay on new sheathing at their own expence. After this experiment they would warrant no more, unless the merchants would take the sheathing at thirty ounces to the foot, and pay for it thirteen-pence per pound: and this is now actually in use.* Thus copper sheathing,

* This they call "*Improved Copper*." The improvement lies in the weight and price; a very pretty improvement for those who sell it! It will be shewn too, presently, that the substance of the metal had not been "improved," but debased.

in *fifteen years*, has jumped from six-pence halfpenny to thirteen-pence per pound; and from thirteen to thirty ounces per foot; so that it now costs more than four times as much to sheath a merchant ship with copper as it did fifteen years ago.

I have been informed by old and respectable merchants, that the copper first used for sheathing, though so much thinner, lasted longer, and answered the purpose better, than any has done lately. There seems to be no difficulty in accounting for this: the sheathing, now called *copper sheathing*, is *not* copper; at least it is not the sort of copper sheathing that was in use ten years ago. It is not the production of our own copper mines; it is, according to the fairest informations that I can obtain, a base mixture of the copper of all countries, old pots, boilers, Birmingham halfpence, bell-metal *skillets*, and *a variety of inferior compounds, in which perhaps iron** has a considerable share.

I confess that I have never analysed *any* of this sheathing, but I hazard the conjecture; and if the copper sellers deny it, how will they account for their copper sheathing being now so inferior to what it was fifteen years ago? and how will they account for its turning, as it fre-

* It may be objected, as iron will not fuse with the same degree of heat as copper, that this cannot possibly be; but I know that iron will fuse, in any metal already fused, with a less degree of heat than is required to fuse it alone; and, I believe, it may be contrived to mix iron with copper.

quently does in sea water, to a *brown* instead of a *green* rust? But whatever be the cause, the effect is certain. It is a notorious truth, that the copper sheathing now in use wastes so fast, that before it has stood *one year* it wants repair; and that it seldom lasts more than three, and often not more than two years, before the ships want almost entirely new sheathing.* From this, and from the enormous price of copper, the merchants of late have not known how to determine on the use of it. Many of them, indeed, at Liverpool, Glasgow, and Bristol, have sent their ships to Africa, the East and West-Indies, and other climates, where the worm and the barnacle are most abundant and destructive, with wood sheathing, because the trade could not support the expence of copper.

* Being lately in Greenland dock, and seeing the Queen East-Indiaman lying there for repair, with her copper in a most deplorable state, I had the curiosity to take from her bottom a small piece of the soundest part of the sheathing. I cut out of it half an inch square, (being in other words, one quarter of a square inch) this weighed exactly six grains, which is seven ounces per square foot.

I was informed in the dock, that this sheathing was, when put on, thirty-six ounces to the foot, so that what remained on the ship had lost just five parts out of six of its original weight; and, I suppose, that there was not above two-thirds of the ship's bottom that had any copper at all remaining on it. From these circumstances, it is pretty clear, that the owner of this ship could not receive a drawback of one-tenth part of the sheathing that was charged to him. This was quite a new ship, having made only two voyages to the East-Indies, and had undergone a thorough repair of her sheathing at the end of her first voyage.

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These considerations have given birth to a variety of projects, for the purpose of superseding the use of copper; but those projects have all of them vanished, either from defects inherent in themselves, or from the overbearing influence of the monopolizers of copper.

The arguments of these men, when any other metallic sheathing has been proposed, have been chiefly these:—1st. That every metal but copper will attract the barnacle, and foul at sea. 2^{dly}. That copper possesses poisonous qualities, which, being extracted by sea water, annoy the worm and the barnacle, and protect the ship from their attacks; and that no other metallic sheathing, for want of these qualities, will answer these purposes.

Whether these notions spring out of ignorance, or deceit, is not material to the question: the impressions made by them have been mischievous, and they are not founded in truth.

It will not be necessary to enter into much theory or scientific reasoning against these positions, as they will be sufficiently refuted by the facts which I shall adduce.

For the first, the truth is, that lead sheathing was in use for upwards of twenty years; and that it was not for “fouling” that it was discontinued; but for rapidly corroding the *iron* bolts and rudder irons of the ships.

As

As to the second, it is certain, that however poisonous copper may be to the human species, it is not so to some kinds of fish; oysters, for instance, on the Cornish coast, and pilchards, when drove to copper banks by larger fish. A cod will live unannoyed and unhurt upon copper banks, and yet, from imbibing the copper influences, will be injurious to the human body as food. And, with respect either to the teredo, or the barnacle, being poisoned by it, I myself have seen many sheets of copper sheathing taken from the bottoms of ships trading to Africa and the West-Indies, and the planks and timbers within so universally bored by the teredo as to resemble a honey-comb; and the barnacles sticking out from the joints and from the interstices of corroded copper sheathing, and sometimes even from the copper itself, not only unpoisoned, but in perfect vigour and the full exercise of their mischievous action.

But even admitting that copper, when first put on, could operate to annoy the worm and barnacle, its whole substance, and of course its poison, are so rapidly dissipated in salt water, that it is evident none of the desired purposes of sheathing can be effectually answered by its use. Besides, as to the teredo, from the very mode of its attack, it is impossible that any poison from the copper can affect it.

Doctor PRICE (before-mentioned) having been engaged in endeavouring to discover some new method of defending ship's bottoms against the teredo, was naturally led to an attentive consideration of the nature
and

and œconomy of this insect's attack; and having set down the result very fully in his "Cornish Mineralogy," I shall not scruple to quote what he has said.

9 — "The Society for the Encouragement of Arts has repeatedly offered premiums for the best composition to pay over ships bottoms, in order to defend them against marine worms, which abound so much in some parts of the East and West-Indian seas, that vessels, new off the stocks, have been frightfully bored in their first voyage.

"Our county being altogether maritime, and the miners being situated in the most narrow part of it, between the two channels, many of our adroit tanners are equally acquainted with naval and subterranean affairs. So true is this, that in St. Ives and Lelant, during the fishing season, they are wholly employed upon the water, to the great hindrance of the adjacent mines; and, when the fishing craft is laid up against the next season, the fishermen again become tanners, and dive for employment into the depths of the earth. We have more than one instance of a common labouring tanner, after he has many years worked underground, becoming so compleat a sailor, as to be entrusted with the command of a large vessel to the Baltic, the Levant, or any other part of the globe.* It

* Let us add, that this *amphibious* race have ever shewn the greatest loyalty and most zealous attachment for our king and constitution; and that, on account of the importance of their

“ It is not therefore to be wondered at, that many of our tinnors and sailors have, reciprocally, attended to the object of the above-mentioned premium: the poisonous qualities of our mundic have ingrossed their attention accordingly, and they have complied with every direction, with regard to the payment of timber, with this poison, but all to no purpose. We have tried it in a preparation of our own, subtilized in such a manner as to be free from those cracks, after it is laid on, to which the mineral, by its specific gravity, when mixed with pitch and tar, is subject. It will be needless to describe how we have tried it upon some of his Majesty's packet-boats at Falmouth, as the experiments did but partially succeed to our wish. *Suffice* it to say, that *no payment, however deleterious to animal life*, will answer our expectations, unless it can be laid on in such a manner, and of such consistence, as to be equally smooth, and free from the least crack or separation; and be of such *impenetrable hardness*, when dry, as to equal metal; which alone is proof against the piercing auger of the teredo: even petrified wood may be bored by the jaws of this worm, which, we are told, will penetrate stone itself.

“ Mons. DE LA VOYE speaks of an antient wall, in the Benedictines' Abbey, at Caen in Normandy, so eaten by *worms*, that a man may run

their mines and fisheries, and the natural extreme sterility of their land, with respect to vegetation, their wants are perhaps more worthy of the attention of the legislature than those of the inhabitants of any other county in the kingdom. When there are insurrections among them *for want of bread*, it might be more humane to put a loaf into their stomachs than a bayonet.

his hand into most of the cavities.* Hence, we will take upon us to say, that no payment whatever, even the *most poisonous*, will effect the resistance required; for the worm, first of all, introduces its auger, which is a callous shell-like insensible instrument, through the matter which is laid upon the wood, and continues working 'till it has made a deep impression into the substance of the timber, when it takes a turn, and works along with the grain of the wood, which it then feeds upon, and not before; whereby we see it has escaped beyond the designed cause of its destruction, before the vital or animal part of it comes into action; so that we may be assured, that no payment will secure our ships bottoms, but impenetrability itself.

“ A quantity of the preparation† here spoken of was sent, some time ago, to an eminent shipbuilder at Rotherhithe, who returned for answer, ‘ That he was very well satisfied that the composition would fulfil the most sanguine expectations; but he thought it not the proper business of a shipwright to advance or encourage any such undertaking, however laudable in the eye of the public; and, he supposed, ‘ every other artificer in his way would be of the same mind.’‡ And,
in

* Philosophical Transactions.

† See p. 64.

‡ The sentiments of this shipbuilder were more ingenuous than those of most of his trade though there are some among this wealthy class of artificers, who, though they will not encourage, yet possess a sufficient degree of patriotism not to suppress ingenious contrivances of

in consequence of this reasoning, a few hundreds weight of this preparation were thrown into the Thames. We likewise recommended a trial of it to another shipbuilder in this county, who ingenuously said, ' That he would first wait some trials of his own upon mundic, very ' finely pulverized;' but he would not regard, or did not understand, my reasons against the bare possibility of his success.

" The effect, however, that cannot be obtained by external application, in the payment of a ship's bottom, may be produced by previously saturating the planks of which the bottom is formed. The planks that are laid upon the bottom or side of a ship are first seasoned, in hot water, in order that they may be flexible, and yield to the form and shape of the mould upon which they are laid. It is, therefore, only necessary to infuse and mix with the boiling medium a quantity

this sort: certainly, it is not to shipbuilders that we are to look for improvement in the *durability* of shipping. Yet there are shipbuilders liberal enough to allow, that if a ship can be made to last thirty years, instead of ten or fifteen, the merchant will be enabled to have two ships where he could before have but one; and the increase of his trade will increase the demand for shipbuilding. They also observe, that if the price of a vessel be, in the difference between iron and copper, reduced one-third, a correspondent saving is made in the articles of interest, risk, and insurance. Whatever enriches the merchant, enables him to employ more extensively the shipbuilder. And this is not merely the language of liberality, but of sound sense. It is the natural course of things, that advantages should beget advantages; and the prejudices at first conceived against the spinning machines, and other contrivances for shortening certain operations, have been entirely done away in various parts of the kingdom, by an abundant and happy experience of the truth of this principle.

of

of the above-mentioned composition, which is one of the most active, impalpable, and subtil mineral minimæ specifically to be obtained; and will insinuate itself, and enter into the pores and vascular constitution of the timber, which, being thus wholly saturated, will have all the power and acculeated exertion of the most effective poison; so that if the teredo penetrate through the outward part of the wood, whenever he turns to feed upon the grain of it, he will be immediately destroyed.”*

The only part of the copper sheathers’ arguments, in support of their sheathing, that remains unanswered, is the assertion, that every other metallic sheathing will attract the barnacle, and foul at sea. This argument seems to suppose the barnacle a sea fish, or marine insect, whose instinct seems to direct it to attack ships’ bottoms; and that, for want of poisonous qualities, nothing but copper sheathing will prevent this inconvenience. The answer is, that the barnacle is not peculiarly a *sea* fish, or *marine* insect.

There are several curious papers published in the Philosophical Transactions, I think, about seventy years ago, to prove that the barnacle

* This hypothesis of Doctor PRYCE, of saturating the wood for planking ships bottoms with his mineral composition, certainly possesses a great deal of ingenuity: were the composition practically answerable to that hypothesis, it would seem to be inestimable; but I do not find, or believe, that any experiments were ever made to ascertain its utility; and the *specific secret*, whatever it was, has been long buried with its ingenious author.

grew on oak trees, and was changed into a bird of the goose kind, in a way similar to the change of the caterpillar into the butterfly; but as these hypotheses are rather too fabulous for the serious design of my book, I must content myself with observing, that its name, as derived by JOHNSON, signifies "The child of the oak;" and he defines it, in his folio dictionary, to be a kind of shell fish, produced by timber laid in water.

The œconomy of this creature seems to be, that, timber in water being its proper matrix, it is either generated ^{on} ~~in~~ it, or settles on it in some early stage of existence, and grows, matures, and continues in that station, until it is removed by some accidental cause, or attains the natural period of its being.

It follows then, that if a vessel be so sheathed as to prevent the water from coming in contact with its timber, the embryo of this creature, whether inherent in the timber, or the water, will be deprived of the causation of its existence. Hence also it must be inferred, that when we see copper-sheathed ships fouled, it must have arisen from the sea water passing through interstices in the sheathing, and penetrating the tarred paper which is placed between the sheathing and the ships' bottoms, and by that means coming in contact with the planks of the ships. This contact constituting, as has been just observed, the matrix by which the insect is produced, the embryo barnacle settled on the plank, and nourished either by the plank, or the water, or both, remains stationary;

stationary; and, as it increases in size and strength, protrudes its hard sharp shell through the sheets of copper, as (from continual and inevitable solution) these sheets become either thin or calcareous. The grafs and weeds found so very plentifully on the bottoms of ships, and which are such impediments to their sailing, are also produced by the same cause, viz. the contact of sea-water with the surface of the wood.

Finally; the assertion of the copper-sheathers, that every metallic sheathing but copper will foul (that is to say, produce these barnacles, grafs, and weeds) is totally unfounded; as metals of all descriptions are absolutely inimical to vegetation.

In these circumstances then, as nothing but a *metallic substance*, as far as we at present know, will answer the end of defending ships from these insects, it becomes an enquiry of great and national concern to ascertain WHAT METAL, OR COMPOSITION OF METALS, FOR SHEATHING SHIPS, WILL BEST DEFEND AGAINST THE TEREDO AND BARNACLE; BEST RESIST THE ACTION OF SEA WATER; LEAST INJURE THE TIMBERS, CALKING, AND IRON WORK OF THE SHIP; FOUL THE LEAST; GLIDE MOST EASILY THROUGH THE WATER, AND, PARAMOUNT TO ANY OF THESE CONSIDERATIONS, FROM THE CONSUMPTION OF WHICH OUR METALLIC MANUFACTURES WILL BE LEAST INJURED AND MOST BENEFITED.

This problem will meet some consideration in the following part of this work, which I shall call

A GENERAL

A GENERAL ACCOUNT OF THE METHODS HITHERTO IN USE FOR PREVENTING CORROSION IN COPPER, IRON, AND BRASS, BY TINNING; AND OF A NEW AND MOST IMPORTANTLY ADVANTAGEOUS METHOD OF TINNING, TO WHICH I SHALL GIVE THE NAME OF

ANTI-CORROSION;

With correspondences, certificates, and other documents, of the Lords of the Admiralty, Master-General of the Ordnance, Officers of the Army and Navy, Merchants, and others, to prove the superior utility of this last-mentioned method; and the importance of its application to metallic works in naval and civil architecture, military, and various other important purposes.

THE improved state of most of our metallic manufactures was, 'till very lately, more owing to casual and accidental discoveries of illiterate workmen, than to scientific investigation.

The study of chemistry had been attended to, chiefly for the gratification of particular interests, or curiosity; and the inventions and discoveries of ingenious and learned men, instead of benefiting society, had generally been lost, when one of the wisest and best men of the age happily thought proper to take up this science, on the most enlarged and philanthropic views; and the popular way in which he
has

has treated it, will, no doubt, bring it into familiar and general application.*

The philosophy of past ages had been rather calculated to display the powers and subtilty of the human mind, than to make men richer, wiser, or happier; and, without vanity, it really seems to have been reserved for the present age, to pursue science from those noblest of human motives, the perfection of public governments, and the general happiness of society.

In an æra, so auspicious to *useful* invention, even ordinary and humble capacities, directed, as it were, into the right road, by the plain and accurate principles ascertained by brighter geniuses, and stimulated by their example, may co-operate in the general advancement of useful knowledge, and gradual command of the powers of nature.†

It was in such happy times, and favourable circumstances, that the author was led, through a course of experiments and observations, to the perfection and application of the discovery which he has called

* Doctor WATSON, the bishop of Landaff, has treated chemistry much in the same way as the late Judge BLACKSTONE treated the law; and it may be hard to say to which the nation is most indebted, whether to the one for his "Commentaries on the Laws of England," or to the other for his "Essays on Chemistry."

† "Natura obtemperando vincitur." BACON.

ANTI-CORROSION: a discovery which, he has been encouraged to hope, may be ranked among the most important of the present or any other times.

The application of tin to copper, for the purpose of preventing it from corroding, is a practice of long standing.

It appears by PLINY, in the thirty-fourth book of his Natural History, that the same method of tinning copper vessels, for the purpose of making them wholesome, and restraining the virulence of rust in them, which we now use, (viz. that of *smearing* the tin over the copper) was known to the Romans at the time he wrote: "*Stannum illitum æneis vasis, saporem gratiorem reddit, et compescit æruginis virus, mirumque, pondus non au-*
~~gmentum~~ and that they had also another method of tinning copper, which I have frequently practised, that of boiling tin into copper. (Plumbum) "*Album incoquitur, æreis operibus, ita ut vix discerni possit ab argento, eaque incoctilia vocant.*" If I do not misapprehend the meaning of this illustrious writer, in the passages quoted, the experiments I have made in reference to it, shew him, to have been mistaken. He says, the copper did not, by being smeared with the melted tin in the first operation, increase in weight; now it is evident that, as in this operation no part of the copper can be wasted, the tin smeared upon it must be so much weight of tin added to that of the copper: but as to the second experiment, upon which he is totally silent as to weight, the weight of the copper, in that operation, might
not

not only be unincreased, but absolutely diminished; for the copper, from being long boiled in the tin, might have been wasted. The experiments I have made in this way, have generally been on pieces of sheet copper; and I have found that when I have taken the copper from the boiling tin, as soon as I have perceived it to be coated by the tin, it has gained weight; and after having put it again into the tin, and left it to boil for a considerable time, I have found, on taking it out and weighing it, that it has lost weight; and, in these last experiments, I have observed this curious fact,—that in the first of them, viz. when the copper has gained weight by being tinned, it has assumed simply the appearance of tin, in which case I take it the copper is merely coated; and when by the second experiment it has lost weight, it has assumed such an appearance, that (like Pliny's *vix discerni possit ab argento*) it can scarcely be distinguished from silver; from which I am led to think, that as the surface of the copper approaches towards a state of fusion, it mixes with the boiling tin, and a partial combination takes place between the two, which produces a new metallic surface on the copper thus treated, materially different both from tin and from copper; so that perhaps the words "*mirumque pondus non auget*" in Pliny, should not have been placed where they now stand, in the first quotation, but have followed the word "*argento*" in the second; a mistake which, considering Pliny as writing popularly, might easily be made.

The former of the processes which he mentions, may probably have been handed down to us by the Romans, but the latter seems to have

been totally lost. He says nothing of any preparation that the copper underwent to enable it to receive the tin. What is now in use for that purpose is a solution of sal ammoniac.

Brafs may be tinned in both the modes I have described; and, by the last process, very elegantly.

The art of tinning iron seems to be of a much later date than that of copper. The only account of its origin that I have seen is given in a valuable little quarto book, published in 1698, entitled "*Englands Improvement by Sea and Land, and the way to beat the Dutch without fighting*," by Andrew Yarranton, gent." by which it appears that the invention of tinning iron plates, commonly called tin-plate, and sometimes block-tin, to which article the tinning of iron was 'till lately nearly confined, originated in Bohemia, was carried from thence by a Romish priest converted to Lutheranism into Saxony in the year 1620, and brought by the adventurous and patriotic Yarranton himself, at the risk of his life,* from Saxony to England, in 1670. From the shortness of life, however, he did not enjoy the fruits of his exertions in this, or any of the many other valuable projects, of which he was

* The punishment of persons, convicted of surreptitiously attempting to carry out of that country, the knowledge of any of its manufactures, was to cover them with tar, and in that state to burn them alive.

the author.† By the knavery of some selfish individuals (who, perhaps, had contributed to the expences of this enterprize, and who artfully obtained a patent for making the material) he was tricked out of all possibility of establishing a manufactory of tin-plates, now so valuable to this country; the patentees, not understanding the process, (though they had sworn they did) never made any plates, and the subject slumbered till about ~~Seventy~~ years ago, when it was revived at Pontipool, and is now known in most parts of Europe, though the English manufacture is the cheapest and most esteemed.

The manner of tinning iron plates is very accurately described by Doctor WATSON, in the fourth volume of his *Essays*, thus,

“ When the iron plates have been either hammered or rolled to a proper thickness, they are steeped in an acid liquor, which is produced from the fermentation of barley-meal, though any other weak

† The idea of cutting canals, through different parts of the kingdom (of which he was the author) was taken no notice of “ ’till he had been dead an hundred years;” that grand medium of commerce—bills of exchange, of the true principles of which he may also be considered as the inventor, was not brought into any general use ’till within these last thirty or forty years; and his rational and comprehensive scheme for establishing publick registries of landed estates, to obviate titles, facilitate loans of money, and avoid the enormous expences that have hitherto attended these transactions, from the intricacies of private titles, and the errors, deceits, and iniquities of the agents* usually employed in them, still remains unattended to.

* I have known instances where attornies, by transferring a loan of money from one name to another, have in a few years gained, from this infamous practice, more than the value of the estate or the security of which the money was first lent. A means of removing these mischiefs may be worthy of consideration, and may very properly make a part of my “ attempt” in a future volume.

" acid would answer the purpose: this steeping and a subsequent
 " scouring cleans the surface of the iron from every speck of rust or
 " blackness, the least of which would hinder the tin from sticking to
 " the iron, since no metal will combine itself with any earth, and rust
 " is the earth of iron. After the plates have been made quite bright,
 " they are put into an iron pot filled with melted tin; the surface of
 " the melted tin is kept covered with suet or pitch, or some fat sub-
 " stance, to prevent it from being calcined; the tin presently unites
 " itself to the iron, covering each side of every plate with a thin white
 " coat; the plates are then taken out of the melted tin, and under-
 " going some further operations, which render them more neat and
 " saleable, but are not essential to the purpose of tinning them, they
 " are packed up in boxes, and are every where to be met with in com-
 " merce under the name of tin-plates, though the principal part of
 " their substance is iron; and hence the French have called them *fer*
 " *blanc*, or white iron. Sir JOHN PETTUS says, that they were with us
 " vulgarly called *latten*, tho' that word, I think, more usually denoted
 " brass.* Tin is not, but iron is, liable to contract rust by exposure
 " to air and moisture, and hence the chief use of tinning iron is to
 " hinder it from becoming rusty; and it is a question of some impor-
 " tance, whether iron of a greater thickness than the plates we have
 " been speaking of might not be advantageously tinned. I desired a

* This may serve to obviate my doubt expressed in the note in page 30, which was printed
 off before I observed this opinion of Doctor WATSON.

" workman

“ workman to break off the end of a large pair of pincers, which
 “ had been long used in taking the plates out of the melted tin; the
 “ iron of the pincers seemed to have been penetrated through its whole
 “ substance by the tin; it was of a white colour, and had preserved its
 “ malleability. It is usual to cover iron stirrups, buckles, and bridle
 “ bits, with a coat of tin, by dipping them, after they are made, into
 “ melted tin; and pins, which are made of copper wire, are whitened,
 “ by being boiled, for a long time, with granulated tin, in a lie made
 “ of allum and tartar. *Would the iron bolts used in shipbuilding be pre-*
 “ *served from rusting, by being long boiled in melted tin?*

The fourth volume of the Chemical Essays, from which the above extract is taken, was not published 'till 1786; but the discovery of boiling tin into iron, which Doctor WATSON made by the breaking of the pincers, and the suggestion of treating iron in that way for ships' bolts, had gone abroad in the newspapers a considerable time before: nor did the hint pass unnoticed: several attempts were made upon it, but unfortunately they were made by mechanics not sufficiently acquainted with the nature of metals, and they all fell short of penetrating the iron.

The two principal claimants of this discovery were a Frenchman, whose name I do not remember, and a Mr. KERR, bit-maker to his Majesty, who at that time lived in the King's-Mews at Charing-cross, The Frenchman applied for a patent, to secure to himself the exercise and benefits of his invention: KERR, getting information of this, claimed

*The matter relates
 Mr. Kerr is in some
 particulars not
 accurate; but
 has been no opportunity
 to correct it.*

claimed the invention as his, and took some steps to prevent the patent from proceeding: after some contention between these two men, each claiming the right of a discovery which belonged to neither of them, it was agreed that the matter should be referred to the decision of Mr. MORE secretary to the society for encouraging arts, manufactures, and commerce. It turned out that the Frenchman was either ignorant of the true principles of this discovery, or else that his interpreter (for Mr. MORE could not at that time speak French) was incapable of understanding and translating his meaning; and the decision of Mr. MORE was in favour of KERR, to whom, with others, the patent was afterwards granted.* It lastly, at a very considerable expence, came into my hands. I soon suspected, however, from the smattering I had

* I incline to think the Frenchman might have been most fairly intitled to the patent in England; for about two years after it appeared by *L'Esprit des Journaux*, Mai 1785, that a discovery had been lately made at Paris of a method of giving to copper or iron a coat of any required thickness, by tinning them: the composition used for the tinning was not mentioned; but it was said that a piece of copper, which in the common way of tinning absorbed only twenty-one grains of tin, absorbed of the new composition four hundred and thirty-two grains; and I am sure Mr. KERR never did any thing like this. I have been informed that this Frenchman was found murdered, soon after it was known that he intended to publish his discovery, and it was supposed to have been done at the instigation of the people interested in the copper-works at Paris, to prevent its getting into general use, which they by this barbarity pretty completely effected; not however by sacrificing the life of merely one man to their purpose, for thousands have since lost their lives in France by eating food dressed in copper vessels, from which the tin has been worn off.

“ France.

I had in chemistry, that I had been too precipitate in my bargain; for the poor old man (Mr. KERR) knew as little of the principles of *his invention* (as he called it) as he did of the substance of the fun.

Though a very young man, I had met with disappointments enough to know that it would be right to make the best of a bad bargain; and, as the first preliminary towards it in my own case, commenced the study of metallurgy. I visited the tin-plate manufactories of London, Pontipool, &c. to discover, if possible, if there were any and what difference between the common process of tinning the plates and the method used by Mr. KERR: the only difference I could discover was, that the tin-plate manufacturers used for cleaning their plates the acid mentioned by Doctor WATSON, [see page 75] and that Mr. KERR used the spirit of sea-salt diluted with water. In all other respects the process was exactly the same, saving the alterations that were necessary for the different articles to be tinned.

I afterwards went to Birmingham; and with some difficulty got admitted into the workshops of the best tinner there, to see the process used by him for tinning small tacks, buckles, &c. He would not let me see him work; but by looking attentively at his apparatus, and

“ France. National Convention, Jan. 17, 1793. A letter was read from the physicians
“ and surgeons of the military hospitals of Dunkirk; who have discovered that the cause of
“ the great mortality which had prevailed of late in these hospitals, was the verdigris which
“ settled at the bottom of the soup-boilers.” ———— WORLD.

conversing

conversing freely with him, I discovered that he used the same acid for cleaning his articles to be tinned, as Mr. KERR used; but instead of putting them, when cleaned, into a pot of melted tin, as the tin-plate manufacturers and Mr. KERR did, he used (as well as I could learn) the following process:—He had an earthen pot, quite round, with a small mouth to it, which would hold probably about a gallon, into which he put the articles to be tinned, and with them so much tin as he apprehended would be sufficient to tin them, which was in general about half an ounce of tin to a pound of articles: he then stopped the mouth of the pot quite close, with a stopper of coarse hempen cloth, and put it into a sort of oven, heated with a fire of charcoal or dry wood, hot enough to melt the tin; in this he moved about the pot and shook it, for some time after he thought the tin might be melted, in order to make the tin stick to the articles; he then took out the pot, and fixed it in a frame made for the purpose of receiving it, removed the stopper, and threw a small quantity of sal-ammoniac into the pot to act as a flux, and replaced the stopper;—he then, by a winch, connected with the frame, whirled the pot round, as on a grindstone, as fast as he could, for five or ten minutes. By this operation the tin completely covered the articles with a thin coat, and, by the help of the sal-ammoniac, ^{was} made ~~to~~ ~~be~~ set quite smooth. When this was done, the mouth of the pot was partly opened, and the articles dropped out, and fell distinctly into a tub of water placed underneath for the purpose of receiving them, which immediately cooled them, and prevented their sticking together, which they would otherwise have done.

• The

The tinner would not tell me what composition he used in this process of tinning; but being permitted to take away a bit of it, I found it to contain about twenty parts of tin and one of copper. So tenacious are these people of their process of tinning, that some gentlemen of Birmingham would scarcely believe that I had ^{even been admitted into one of their shops:} ~~seen it~~. This man told me that he gave an hundred guineas, and seven years service, to learn this art from the person who invented it; that there were only two more in Birmingham who understood it; and that it was not known in any other part of the world. The articles tinned by this man had a very smooth and silvery appearance; but the coat of tin laid on by this mode of tinning is so very thin, that it soon wears off.

I found also, that currycombs were tinned, by cleaning them with spirit of sea salt diluted with water, and then dipping them into pots of melted tin; and at Walsal, (near Birmingham) a town whose manufactures consist chiefly in bridle bits, stirrups and sadlers' ironmongery in general, I learnt that those articles had been tinned in the same way there for twenty or thirty years; so that the only thing to be claimed by Mr. KERR was—the novelty of the application of tin to articles not before usually tinned, and that, in fact, was suggested by Dr. WATSON.

By no means discouraged, however, by the result of my enquiries, I set about making experiments of all kinds that my imagination could suggest in reference to these subjects: I knew that it was possible to boil tin

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into

into iron, not only because Dr. Watson had said it, (though that, as I considered his veracity to be unimpeachable, would have been enough to have induced me to believe it) but because I had made a similar discovery myself, by a similar accident; but I found that the *time* requisite to perform it was near a week, which made it too tedious an operation for a popular manufacture. To discover a means of capacitating the iron to receive the melted medium into its pores *in a short time*, was the object to be aimed at, nor did I despair of making that discovery: It became necessary, in the first place, to find out *how* the tin penetrated the iron, and *why* it took so long a time;—at length it struck me, that it was the continued heat that the iron underwent while in the boiling tin, that softened it, and opened its pores, and by that means enabled the tin gradually to impregnate it. This idea induced me to make the tin so hot as to cause the iron that was put into it to be soon red hot; and by this experiment I found the tin penetrated the iron pretty considerably, in a much shorter time than when the tin was not hot enough to make the iron *red* hot.

The circumstance mentioned by Dr. WATSON,* of the bottom of an iron pump being so softened by standing in a well of vitriolic water in the coal-works at Whitehaven, that a man could cut it with a knife as easily as he could cut black lead, led me to conceive that to soak the iron for a considerable time in a strong vitriolic water before immer-

* Vol. L p. 218.

ging it in the melted medium might answer my purpose; and by these and some other experiments (which, as the success of the operation chiefly depends upon them, I think I may be fairly excused from publishing) I have discovered a method of impregnating iron sufficiently deep to defend it against corrosion long enough for the common purposes to which it is applicable, in a space of time short enough to render the manufacture sufficiently cheap for general application and consumption:—I shall therefore now give a general description of the process, which I call *ANTI-CORROSION*, and then proceed to some experiments, which may explain the effect it has in preserving iron against the attacks of rust—some observations on its applicability to various important purposes, and on its superiority over the metals now in use for such purposes.

The process then, by which anti-corrosion is effected, consists in a certain preparation of iron (a substance naturally *susceptible of corrosion*) by which preparation that substance is rendered capable of imbibing certain metallic mixtures (in fusion) that will not corrode nor be corroded for many years; and then in immersing and boiling such iron in such metallic mixtures, until its pores are completely saturated (or impregnated, filled, and closed) and its surface is strongly coated; by which it is effectually defended against rust and corrosion, whether occasioned by the action of the atmospheric air, or damps, or water, or the saline alkali or acid particles of sea water, or any other of the common causes of corrosion in simple iron.

This account will, it is hoped, suffice to indicate the principles of the anti-corrosive process, as well as the uses and advantages of the discovery in general; to which therefore it need only be added, that its existence and important utility does not rest merely upon speculative probability, but likewise upon many and various demonstrative experiments, repeatedly made under the inspection of severe and intelligent observers, whose letters and certificates are here published for the conviction and satisfaction of the reader.

EXPERIMENTS.

It was submitted to the consideration of the Lords of the Admiralty, (in a state very short of its present perfection) for ships' bolts, &c. in the year 1783; and by their Lordships' directions, the following experiments were made, viz. On the 28th of April 1783, two prepared iron bolts, fit for large ships, were driven into a piece of GREEN TIMBER, COPPERED, in the same manner as in ships' bottoms;—two other bolts were driven into a piece of GREEN TIMBER NOT COPPERED; two others into a piece of DRY TIMBER COPPERED, and two others into a piece of DRY TIMBER NOT COPPERED. All these were put to float in sea water at Portsmouth, where they remained two years and three months, viz. till the 12th of July 1785, when, by order of the Navy Board they were taken up; and all of them came out as found and perfect, as when first driven; as appears by the following certificate from the Officers of Portsmouth yard to the Navy Board:

“ Portsmouth, 12th July, 1785.

“ In obedience to your directions of the 26th and 28th April 1783,
“ we have taken up the bolts drove, &c. and laid down agreeable to
“ your above directions, packed them in four boxes, and put them on
“ board the Deptford transport, bound for the River, the boxes marked
“ as under, viz.

“ Bolts drove in *green* timber — *coppered*.

“ Ditto — — — *not coppered*.

“ Bolts drove in *dry* timber — *coppered*.

“ Ditto — — — *not coppered*.

“ and beg to observe that *we did not find them in the least injured*.

“ Having been drove only two years, we think the time too short
“ for a proper experiment.”

After this experiment, an application was made to the Navy-Board to get the manufacture introduced into his Majesty's Navy, but from some impediment or other, it was not attended to:—the application was then directed to the Lords of the Admiralty; the result of which will appear by the following correspondence:

*Copy of a letter from PHILIP STEVENS, Esquire, Secretary of the Admiralty,
to the Proprietor of this discovery.*

“ SIR, Admiralty-Office, 23d Sept. 1785.

“ My Lords Commissioners of the Admiralty, having referred to the
“ Navy Board for their consideration, the proposals which their Lord-
“ ships

“ ships received from you the 14th instant, for introducing your bolts
 “ into use in the Royal Navy, and directed that Board to let them
 “ know the difference of expence between your bolts and copper bolts;
 “ and the Navy Board having, by their report of the 20th instant, re-
 “ ported that they are of opinion the use of copper bolts succeeds so
 “ well as to supersede that of all others, and that they apprehend they
 “ are cheaper* than the bolts invented by you, from the comparison
 “ that accompanied their letter;—I am commanded by their Lordships
 “ to send you herewith copies of the said letter and comparison for
 “ your information.

“ And am, Sir, &c.

(Signed) “ PHILIP STEVENS.”

COPY of the LETTER inclosed in the above, viz.

*The Commissioners of the Navy Board to Mr. STEVENS, Secretary of the
 Admiralty.*

“ SIR,

Navy-Office, 20th Sept. 1785.

“ In answer to your letter of the 15th instant, signifying the direc-
 “ tions of the Right Honourable the Lords Commissioners of the Ad-
 “ miralty, to take into consideration the proposal for introducing the
 “ prepared iron bolts into use in the navy; and at the same time to let

* It will appear, in the course of this work, that the respective advantages and disadvantages of these two rival manufactures, were not sufficiently specified, compared and considered, to be understood by the Honourable Board.

“ their

" their Lordships know the difference of expence between the said bolts
 " and copper bolts; we desire you will please to acquaint their Lord-
 " ships, that we are of opinion the use of copper bolts succeeds so
 " well as to supersede that of all others; and we apprehend they are
 " cheaper than the new ones, as appears by the inclosed calculation
 " of each. We are, &c.

(Signed) " EDWARD HUNT, GEORGE MARSH,
 " CHARLES MIDDLETON, EDWARD CRAS."
 " J. HENSLow,

The calculation inclosed.

	<i>Per Ton.</i>
" Copper bolts at 10½d. per lb. equal to	£.95 13 4
" Returned copper, at 7½d. equal to	72 6 8
Remains	23 6 8
" Iron bolts at 1l. 15s. per cwt. or, per ton,	35 0 0
" Process at	25 0 0
Total	60 0 0
" Returned iron bolts at	10 0 0
" Remains	£.50 0 0

To this letter and comparative calculation, the Lords of the Admiralty
 were answered to the following effect:

" May

“ 29th September, 1785.

“ May it please your Lordships!

“ I have the favour of your Lordships' letter of the 23d instant,
“ inclosing the comparison made by the Navy Board, between copper
“ bolts and mine.

“ I have in answer to inform your Lordships, that the Navy Board
“ are greatly mistaken, in their estimate of my bolts, particularly in
“ the article of iron, set at 1l. 15s. per cwt. or 35l. per ton

“ I am certain that the best iron may be bought	}	£.	s.	d.
“ per ton for		16	0	0

“ The workmanship of forged bolts is done by the	}			
“ piece at 4s. per cwt. which per ton is only		4	0	0

“ A full allowance for coals and tools per ton		1	0	0
--	--	---	---	---

“ The total expence per ton, instead of 35l. as stated	}			
“ by the Navy Board, is therefore only		21	0	0

“ All bolts, above an inch over, are forged out of square iron; bolts
“ under an inch over are mostly milled, and may cost somewhat more
“ than 16l. per ton from the mill; but the expence of workmanship
“ is very trifling, as two men will cut and head six ton a week.

“ The wages per week of the foreman	—	£.	1	2	6
“ Of the helper	—		0	15	0
“ For six tons			1	17	6
“ Or per ton			6	3	

“ So that *milled* bolts will not cost near so much as forged ones.

“ With respect to my bolts, when taken out of a ship, the Navy Board have considerably undervalued them; for, as it is demonstrated that they do not corrode,* they will certainly serve again, so that there will be a saving of all the iron.

“ Your Lordships will be pleased to consider that the *drawback* upon copper bolts is the chief object in reducing their price, but *when* does that drawback come? Does not the interest of the first heavy charge constantly accumulate, 'till the ship is broken up or new bolted?

“ The *duration* of my bolts so far exceeds that of copper, that were the calculation of the Navy Board wholly true, it is highly probable that the whole expence would be saved in repairs alone. I therefore hope your Lordships will be pleased to order some ship to be fitted out with my bolts on a three years station, to give them a fair trial, and, if found to answer, I am so thoroughly convinced of the difference of the price of copper bolts and mine ultimately, and upon a

* The Navy Board had no reason to presume that they *would* be corroded, for the experiments made on them at Portsmouth, under their own direction, had proved the direct contrary.

“ full and fair calculation, that I will undertake to perform a contract
 “ 10l. per cent. cheaper than the present contract for copper; for I am
 “ decidedly of opinion, that, if ever put in practice, the saving will be
 “ a vast deal more.

“ I have the honour to be, &c.

I shall now beg leave to make a few additional remarks on the Navy Board's calculation, and comparison of the difference of expence, between the copper and prepared iron bolts.

In this calculation, the Honourable Board appear to have quite forgotten the *interest* of their 95l. 13s. 4d. paid out of pocket, for every ton of copper bolts for the fifteen years they were to remain in the ship, before the time of the drawback should arrive, which interest at 5l. per cent. happens to be upwards of 70l. And they also appear to have taken it for granted, that for *every ton* of copper bolts they should drive *into* a ship, they should get a ton *out of* her.

But I am informed that it is a convenient custom with the people who are employed in ship-building in his Majesty's yards, to apply to their *own* purposes, as WASTE, the copper that is *cut off* from the *ends* of the bolts when driven, which often happens to be an eighth or tenth of the whole, and sometimes more; and copper bolts waste to such a degree by corrosion, that what with this lawful *clipping*, and what with the subsequent waste, (to which we may add the unavoidable

able thefts of workmen*) Government, instead of getting a drawback of *ton for ton*, is well off, if it gets a drawback of *one third part* in weight of the bolts originally charged to it's account.†

The Navy Board certainly could not have been aware of these things, when they made the calculation referred to, otherwise they would not have attempted to shew that a ton of copper bolts cost government only 23l.

Now let us turn to the other side of the account, and examine their calculation of a ton of *prepared iron* bolts at fifty pounds.—Iron bolts, that might have been bought for less than twenty-two pounds per ton, they set down at thirty-five pounds per ton, more than *one-third too much*; and the drawback, which they ought, at least, to have set down at fifteen pounds per ton, they set down at ten pounds, just

* I am informed that government has lately expended two thousand pounds, in endeavouring to discover the mode by which these depredations are carried on; and it at length appears, that the copper bolts are cut in pieces, and carried out of the yards, concealed in holes bored in the chips of wood, which, from custom, are considered as rightful perquisite: The Lords of the Admiralty have offered advantages more than equivalent to the perquisite of *wooden* chips, but the offer has been rejected, and the depredations continue *inviolable*: The anti-corrosion would at least have the merit of precluding this mischief; because the material could only be stolen in *bits*, and those, from the difficulty of cutting them, and from their inferior value, would not be worth stealing.

† I should be glad to know how much copper government has paid for, since the year 1774, and on how much it has received a drawback.—See note, page 60.

one third too little; and thus they make it appear, that *prepared iron bolts*, which could have been bought for less than forty-seven pounds per ton, would be twenty-five pounds per ton dearer than copper bolts, which could not be bought under (upwards of) ninety-five pounds per ton.

On this topick of the Navy Board's comparative calculation, and on any others of a similar kind that may occur, I have only to express a general wish, that men in office might consider it their serious duty, to be fully informed of the real merits of every scheme professing the publick good, and the rectitude of every calculation sanctioned with their names; and trust less to clerks and secretaries—the common screens between official integrity, and the base corruptions of interested individuals.

But to proceed:—In consequence of the letter of the 29th Sept. 1785, the Lords of the Admiralty ordered about three hundred pounds weight of prepared iron bolts to be driven in the *Cygnet* sloop of war, then preparing for a three years cruise on the Jamaica station, as a further trial. This was the oldest sloop in the navy, and the prepared iron bolts were driven into holes, out of which copper bolts had been taken, and the ship was coppered over the bolts for the purpose of making the trial as severe as possible. This ship having failed for her station, it was found necessary to keep her there five years and upwards, instead of three.

But

But Mr. Richards, who was master of her sometime during her station in Jamaica, having returned to England in January 1791, a friend of the Author's wrote to Mr. Richards, to know how the bolts stood when he left her, and to his letter he received the following answer:—

“ SIR,

Niger at Spithead, 11th Jan. 1791.

“ I received your's, requesting me to inform you what I knew respecting the prepared iron bolts driven into the Cygnet sloop.

“ I have not a doubt but they will fully answer your expectation.
 “ I was in her about twenty-one months, during which time we were
 “ a great deal at sea, and in very bad weather. I had several opportunities of seeing the heads of the bolts in the hold; and on heaving
 “ down where we took off the copper to drive the gammoning bolts,
 “ the copper was not in the least injured on the inside by the bolts,
 “ nor were the bolts by the copper, but appeared perfect and bright.
 “ I am sorry they had not a fairer trial, as the Cygnet is, I believe, the
 “ oldest sloop in the service, and was, when we sailed from England,
 “ in a very indifferent state. I hope her arrival in England will soon
 “ convince the publick of the very great service of your friend's invention.

I am, Sir, &c.

GREGORY GARD RICHARDS.

The

The Cygnet did not return to England 'till the month of August 1791; and, in October in that year, five of the prepared bolts were knocked out, and proved to be as sound, and appeared as bright, as when first driven, except one, which was corroded a little in a small spot, where the iron, being very bad, had not effectually received the preparation. The heads too, which had been battered to pieces in being driven without a proper apparatus, were discoloured, but not in the least degree wasted.

These bolts were left with the Officers of Portsmouth yard, to be transmitted to the Navy Board. But, alas, poor bolts! after encountering, first an immense difficulty in getting permission to be introduced into the Cygnet sloop at all,—after a five-years' station at Jamaica and safe return to Old England,—after having, for upwards of five years, withstood the united cankering powers of a Jamaica atmosphere, and of copper and sea water—a successful conflict with heterogeneous and hostile principles;—after having, probably, saved the crew of an old battered vessel from drowning;—these poor bolts, I say, with all these merits, so soon as they arrived on British ground, lost, it seems, all their virtues! Under the fostering care of these Portsmouth Officers, in taking their passage from thence to London, they were lost—mysteriously lost, for ever!

These bolts being thus gone, with all their possible advantages, I applied to the Navy Board to get some more drawn, and the following letter contains the answer to that application:

“ Navy-Office, 22d February, 1792.

“ Mr. Langworthy,

“ In answer to your letter of the 16th instant, we acquaint you, that
“ the Officers of Portsmouth-yard have again represented to us, they
“ cannot drive out any more bolts from his Majesty’s sloop Cyg-
“ net, until she is taken into a dock; and further observe, that she is
“ now laid as a break-water for the security of the dam to the new
“ dock.

“ We are, your affectionate friends,

(Signed) HENRY MARTIN,
 J. HANSLOE,
 GEORGE MARSH.”

Having heard nothing more from these “ *affectionate friends*,” and the Cygnet not being yet taken into a dock, I cannot give any further account of this experiment than is already before the reader.

To give certificates of all the various experiments which have been made on nails, of the anti-corrosion preparation, would perhaps dilate this narrative too much; I shall therefore, to be as brief as possible, give only a few, which I trust will be sufficient to prove the utility of the discovery, in the composition of nails, and with what success the anti-corrosion nail has been used in Merchant ships trading from Liverpool to Africa.

Mr.

Mr. JOHN KEWLEY, merchant, Liverpool, to the Proprietor.

“ Sir,

Liverpool, 20th April, 1791.

“ I have not lost a moment's time to advise you that the ship *King Grey* was this day put into the graving dock; about this time twelve-month she was repaired, and hath since made a voyage to Africa; she had three streaks of wood sheathing under the bends above the copper, nailed with your composition nails; and, in order that you as well as others, may see that your nails are as fresh as on the day they were drove, I have sent you a few pieces of the sheathing board, which will convince merchants, shipwrights, &c. they will answer the end.

“ I shall to-morrow have one of the sheathing boards exhibited at 'Change for the inspection of our Liverpool merchants.

“ And am, Sir,

“ Yours, &c.

(Signed)

“ JOHN KEWLEY.”

“ Sir,

Liverpool, 21st April, 1791.

“ I wrote you by yesterday's post, and at the same time sent you a few pieces of the sheathing boards, with the nails stuck in as they came off the ship *King Grey*. This day I had a plank brought to the 'Change, with the nails just as taken off the ship's bottom; they appeared

“ appeared as fresh and as bright as when driven, which the principal
 “ merchants and ship-builders of this town saw and approved; and
 “ have most of them promised to make use of them. You had last
 “ summer ~~an~~ ~~one~~ for bolts and nails for a small vessel I am part-owner
 “ of, since which she hath made a voyage to Africa, and is now in
 “ the dock, and the nail heads in her deck look as bright and fresh as
 “ when they were driven. I am confident that your composition
 “ would answer in America and the West-Indies, for hinges for doors,
 “ window-shutters, &c. as those made of common iron decay very
 “ fast in these climates, by being eaten out with rust.

“ I am yours, &c.

(Signed) “ JOHN KEWLEY.”

“ SIR,

Liverpool, 10th June, 1791.

“ In regard to the ship which I am part-owner of, in which your
 “ bolts and nails were used, she failed upon her second voyage four
 “ months ago; all that I can say respecting her is, that the nails in her
 “ deck, and all that could be seen, were then as bright as the day
 “ they were driven, and I make no doubt but they will be found so
 “ when she returns again.

“ I am, Sir, your's, &c.

(Signed) “ JOHN KEWLEY.”

CERTIFICATES OF MERCHANTS, &c. OF LIVERPOOL.

“ WE whose names are hereunder subscribed, do hereby certify,
 “ that in the month of April 1792, on the return of the ship King
 “ Grey from Africa, she was put into the Graving dock, No. 3, Liver-
 “ pool, and we attended her and saw the sheathing under the bends
 “ above the copper stripped, which sheathing was nailed with the new-
 “ invented prepared iron nails, that the said nails were driven in the
 “ month of April 1790, since which the said ship has been two voyages
 “ on the coast of Africa; and we do hereby further certify, that the
 “ said nails, when the sheathing was stripped, were as bright, sound,
 “ and fit for service, as when first driven, and that the same (except
 “ what have been kept for curiosity) are used again accordingly. Wit-
 “ nefs our hands this 23d day of August, 1792.

“ RALPH ABRAHAM,	} Merchants,	{ Part-owners of the ship King-Grey.
“ JAMES WELSH,		
“ JOSEPH CASH, Captain or Master of the said ship.”		

“ WILLIAM ASPINAL, JOHN KEWLEY, JAMES FORREST, WILLIAM
 “ TEASDALE, JOHN HOUGHTON, JAMES COSNAHAM, DANIEL HEN-
 “ SHAW, and a variety of others who attended the stripping of the
 “ sheathing, and saw the prepared nails after it was stripped.”

Another

Another Certificate.

“ We whose names are hereunto subscribed, do hereby certify, that
 “ in the month of July last, we attended the stripping of the sheath-
 “ ing of the ship Bud, in the Graving dock, which, in September
 “ 1789, was nailed with the prepared iron nails, and that the same
 “ were so bright, sound, and fit for service, that all of them, except
 “ a few, which were saved for curiosity, were used again, for nailing
 “ on the new sheathing; and that they had not in the least degree in-
 “ jured the sheathing or the planks of the ship, but were drawn with
 “ as much ease as they were driven with, and that the said ship has
 “ made two voyages on the African station since she was sheathed with
 “ the said nails; and that she is intended for another voyage with the
 “ same, and from all appearances they will last many voyages more,
 “ as neither their heads nor bodies are at all corroded.

Signed 23d August, 1792, by

“ WILLIAM ASPINAL,	}	Owners.
“ RALPH ABRAHAM,		
“ JOHN WATSON,		

“ N.B. Some common iron nails were driven in the same sheathing,
 “ and nothing remained of them but rust.”

The above certificate is also signed by the same gentlemen who
 signed the other.

The ship builder, under whose direction the said ships were, actually refused to sign the above certificates, (after having promised to do it) and assigned as a reason for such refusal, that "*he should get the ill-will of the ship carpenters, who,*" he said, "*would lose many a good job if these nails were brought into use.*" Mr. Watson the mate said, that, had he not attended the stripping, the carpenters would have thrown away the nails to have prevented their being seen.

Prepared musquets, for the use of soldiers and marines, have undergone very severe trials to ascertain the utility of this discovery in these articles, as will be seen by perusing the following correspondences with the Duke of Richmond, and the officers of the army and marines, to whom his Grace referred the necessary experiments.

His Grace the Duke of RICHMOND to the Proprietor, in answer to his first application.

" SIR,

Goodwood, Dec. 23d, 1784.

" I have received your letter of the 9th instant, stating that you have
 " discovered a preservative of iron from rust, which is now under ex-
 " amination by the Navy Board, and desiring me either to investigate
 " this invention myself, or to order some other person so to do. As I
 " am now in the country, and have a great deal of other business to
 " attend to, I shall not be able to examine it myself; but I have written
 " to Major Bloomefield to desire him to call on you for the explanation
 " of

“ of it you offer, and to report on its utility, and what course of experiments he would recommend to ascertain the effects.

“ I am, Sir,

“ Your most obedient humble servant,

(Signed)

“ RICHMOND, &c.

After this letter was written, upwards of nine months elapsed on account of the various business his Grace had to attend to, before any thing further was done. On the 16th November, 1785, his Grace was written to again, and on the 18th returned the following answer:

“ SIR,

Whitehall, Nov. 18th, 1785.

“ I have received your letter of the 16th instant, respecting your discovery of a method of preserving iron from rust. I should be glad to know to what purposes you think your discovery will be applicable, and what your expectations from the Ordnance are, in case your invention is found to be useful.

“ I am, Sir, &c.

(Signed)

“ RICHMOND, &c.

The Proprietor's Reply to the above.

“ May it please your Grace,

21st Nov. 1785.

“ I have the honour to acknowledge the receipt of your Grace's letter of the 18th instant, requesting to know to what purposes my discovery

“covery for the preservation of iron from rust may be applied, and
 “what my expectations are from the Board of Ordnance, in case it be
 “found useful.

“My answer to the former part of your Grace’s request is, that I
 “humbly conceive the immersion of gun-barrels, pistol-barrels, and
 “locks, in the preparation alluded to, would not only preserve them from
 “rust in those climates where such effects are produced, but increase
 “the durability of them exceedingly, consequently save a great expence
 “to Government, much labour to the soldiery, and, what is last in
 “consideration, add infinitely to the beauty of their fire-arms.

“To the latter part—in case my invention be found useful, my terms
 “will be no object in comparison to its utility.

“I have now the satisfaction to inform your Grace, that the Lords
 “of the Admiralty and Navy Board, on Friday last, came to the de-
 “termination (after repeated experiments, during the space of two
 “years and a half) of fitting out a frigate with iron bolts prepared
 “by me, as a final assay prior to my engagement with them.

“I should be glad to have the honour of waiting on your Grace
 “with a specimen of the prepared bolts, and to explain, more fully,
 “every particular, which cannot so satisfactorily be committed to
 “paper.”

The

The Proprietor, to his Grace the Duke of RICHMOND.

“ London, 5th May, 1786.

“ May it please your Grace!

“ Some time since, I took the liberty of informing your Grace, that
“ the musquets deposited with me by Major BLOMEFIELD, were ready
“ for your Grace's inspection; but concluding that this circumstance
“ had escaped your memory, I again take the freedom of communica-
“ ting the same, and earnestly hope that any trial, it may be thought
“ expedient they should undergo, may be put in practice as soon as
“ possible. I am, &c.”

These musquets were sent to his Grace for experiment, and the following letters will shew how they answered :

“ SIR,

“ Whitehall, 1st August, 1788.

“ I am to acquaint you, that I sent three of the musquets you had
“ prepared on board three different ships for trial.

“ Inclosed I send you a copy of the report I have received concern-
“ ing that which was sent to Newfoundland, under the care of Major
“ ARNOTT, on board his Majesty's ship Salisbury; and also, a copy
“ of the report upon that which was sent to the coast of Africa, under
“ the care of Lieutenant Lee, of the Marines, on board his Majesty's
“ ship Adventure.

These

“ These two musquets are now here for your inspection, but the
“ third is still on board his Majesty’s ship Solebay, in the West-Indies;
“ and I do not expect to receive it, or any report concerning it, until
“ the return of that ship next year.

“ I am, Sir,

“ Your most humble servant,

(Signed)

“ RICHMOND, &c.”

COPY OF THE REPORTS.

“ Portsmouth, 28th Nov. 1786.

General SMITH, to his Grace the Duke of RICHMOND.

“ My Lord Duke,

“ Major ARNOT landed this morning from his Majesty’s ship Salif-
“ bury, and brought with him the prepared firelock entrusted to his
“ care, which appears to me to be pretty much in the same state as
“ when he received it; the firelock in coming from London, had got
“ loose in the case, and was a little rubbed on the barrel.

“ I have the honour to be

“ Your Grace’s

“ most obedient,

“ humble servant,

(Signed)

“ HENRY SMITH.

L. G. M.

Major ARNOTT's letter to General SMITH, inclosed in the above.

“ His Majesty's ship Salisbury,

“ SIR,

“ Spithead, 28th Nov. 1786.

“ On our passage out, when on the banks of Newfoundland, I hung
“ up the *prepared* firelock and one of the common arms under the half
“ deck; the weather was very foggy for ten days: the prepared fire-
“ lock remained in the same state as at first, except such parts of the
“ lock as will not admit of being prepared; and, during our stay at
“ Newfoundland, it was used in turn by the sentries, and always at
“ exercise in firing by platoons, &c. all of which made no alteration
“ in it. I do not find any inconveniency attending the preparation,
“ rather otherwise, in bad weather especially, as the arms are liable to
“ get wet with salt water, and the men have not time to clean them.

“ I am, Sir,

“ Your most obliged humble servant,

(Signed)

“ THOMAS ARNOTT,

“ Major of Marines.”

[Copy of Lieutenant LEE's Report,—lost.]

Mr. CREW, secretary of the Ordnance Office, to the Proprietor.

“ SIR,

“ Ordnance Office, 22d Sept. 1788.

“ I am directed by his Grace, the Master-General, to transmit to you
“ the inclosed copy of a certificate from Lieutenant HUNT, of the

P

“ marines,

“ marines, dated 13th instant, respecting your prepared musquet,
“ which was sent on board the Leander, when she sailed for her
“ station at Halifax, in 1786; and to acquaint you, that the said
“ musquet was in the charge of a corporal during the voyage, and
“ was not so much exposed to the weather as the musquets of the
“ privates.

I am, Sir,

“ Your most obedient humble servant,

(Signed)

“ R. H. CREW.”

Lieutenant HUNT's Certificate.

“ Plymouth Barracks, 13th Sept. 1788.

“ My Lord Duke,

“ On the 7th September, 1786, I embarked on board the Leander,
“ for America; and, with the party, was sent a musquet plated with
“ metal; which musquet was occasionally used by the centinels, and
“ *always* fired with, when we exercised small arms; *it required no re-*
“ *pair while abroad, and when landed in August, 1788, was perfectly fit*
“ *for service.*

(Signed)

“ N. AUGUSTUS HUNT,

“ 1st Lieut. Marines.”

I have permission to add a letter from Major ARNOTT to his friend
Major VARLO.

“ Dear

“ Dear VARLO,

Portsmouth, 8th June, 1788.

“ I have been at the office, but cannot find that a copy of my
 “ letter to General SMITH, concerning the musquet, has been inserted
 “ in the divisional books;—I was in hopes I had kept one myself, but
 “ have rummaged over all my papers without finding it. General SMITH
 “ is not here; it is possible he may have a copy; if so, I will write you.
 “ I have got a copy of the Duke's letter to the General, as also the
 “ General's answer to him, stating that he had sent the firelock with me;
 “ to the best of my recollection, my answer was something near to what
 “ follows:—The firelock, on my receiving it, was a little rubbed in
 “ the barrel by the wooden case which it came in from town, and on
 “ our getting on the banks of Newfoundland, I hung it up under the
 “ poop, and a bright ship's musquet the opposite side, almost every day
 “ the ship's firelock required cleaning, while the prepared one was just
 “ the same as at first, excepting such parts of the lock as were not done
 “ over with the preparation. I made the sentries use it frequently on
 “ the gangway, and had it always in use, when exercising with powder,
 “ both on shore and on board; and the invention seemed to answer
 “ remarkably well, particularly in bad weather, when the men had not
 “ time to clean their firelocks.

“ What I have mentioned above is as near as I can recollect. The
 “ fleet under Admiral Leveson is to sail this morning.

“ I am, &c.

(Signed)

“ THOMAS ARNOTT.”

The Duke of RICHMOND to the Proprietor.

“ SIR,

Goodwood, 22d August, 1791.

“ I received your letter of the 4th instant; and as the report of the
“ firelocks prepared with your composition, made by Captain LEE,
“ is not to be found in my office, I imagine the original report has, by
“ mistake, been sent to you instead of a copy of it, which is the reason
“ I omitted to mention it in my letter to you of the 23d of last month.

“ However favourable that report might have been, it will not affect
“ what I have already stated to you, respecting the price you demand
“ for preparing the firelocks; for I do not think that the advantage to
“ be derived from your invention, can be worth *three shillings and six-*
“ *pence per firelock*, which is the lowest price you say you can prepare
“ them for.

“ I shall be glad if you will return me Captain LEE's report, after
“ you have taken a copy of it. I am, Sir,

“ Your most obedient, humble servant,

(Signed)

“ RICHMOND, &c.”

N.B. Since the receipt of the above letter, the author has received a quantity of musquets from the Ordnance, which he is preparing at *three shillings* apiece; being willing to sacrifice his own interest to that of the publick.

FURTHER.

FURTHER EXPERIMENTS.

About five years ago, some iron nails prepared, and others not prepared, were driven into a piece of timber; and the timber, with the nails in it, was laid down in the river Thames near Gravesend, in the same manner as the bolts were at Portsmouth, between high-water and low-water marks, so that it might be covered at every flowing, and left dry at every ebbing of the tide. In the course of three years, by this experiment, the common nails were almost entirely consumed by rust, but the prepared nails were as perfect as ever, and remain so to this day.

Sheet iron and sheet copper, after preparation, have been wholly and constantly exposed to the atmosphere, without any appearance of decay.

Ships' bolts have been left six years, in a cellar constantly overflowed at spring tides; and they are still there perfectly sound and uncorroded.

A great variety of chemical experiments has been made on this manufacture, by gentlemen particularly learned and ingenious in that science, to their entire satisfaction; and I cannot here refrain from making my most grateful acknowledgments to some who, in those and other respects, have exerted their utmost endeavours to promote my undertaking.

The

The Right Honourable Lieutenant General MURRAY,* the learned and philosophical Dr. JOHN INGENHOUSZ,† the ingenious WILLIAM FITZ-GERALD, esquire, of the Inner Temple,‡ and the late Mr. JOHN CRANCH,§ have particularly obliged me.

My

* Equally known for his skill and intrepidity in the field, for his extensive knowledge and warm encouragement of the liberal arts, and for the extreme benevolence of his disposition.

† Physician to the late and present Emperors of Germany, the value of whose chemical works, from their being written mostly in French and German, is at present lost to many ingenious Englishmen. I have been lately honoured with the doctor's permission to translate them into English, and publish the translation.

‡ A barrister, and very ingenious mechanic. Among a variety of other useful things, he has made some very important improvements in the application of steam to mechanical powers, and in machines for spinning wool and cotton.

§ A very deserving native of Kingsbridge in Devonshire, whose simplicity of manners, sweetness of disposition, versatility of talents, extensive knowledge, and profound judgment, I had flattered myself, as he had honoured me with his notice, would have made him a most valuable acquaintance to me. But, on my return to London from the country in November, to my great disappointment and sorrow, I was informed, that, from too severe an application to the study of painting, and of the preparation of colours, his health was so impaired, that, being advised to quit London, he had gone into the West of England, where he shortly after died.

I have been accidentally favoured with some MSS. of his, which lay in the hands of one of his acquaintance in town. One of these manuscripts is a letter written to a friend who had
submitted

My sincere thanks are likewise due to Mr. JOHN KEWLEY, of Liverpool, for considerable friendly services, and to WILLIAM LAMB, esq; a barrister, of the Inner Temple, for a variety of services among his friends, particularly for his writing to Sir GEORGE YOUNG; whose answer to Mr. LAMB, as I am in possession of it, I here take the liberty of publishing.

submitted to his consideration the form and intentions of his will; and, as I think its publication will be of general utility, I have taken upon me the charge of printing and publishing it, under the title of "*Reflections on the mischievous consequences generally arising from the usual dispositions of property by will.*" If Mr. CRANCH has left any relations living in England,* I shall be very happy to account to them for the profits, if any should arise from the sale of the book. Another of the manuscripts is an irregular poem in blank verse, entitled "BUCKFAST ABBEY," written at the age of eighteen, in a very pure stile, and possessing many beauties. And the third manuscript is a profound criticism on Dr. JOHNSON's, Mr. POPE's, and Mr. THEOBALD's prefaces to Dr. JOHNSON's edition of SHAKESPEARE's plays, (octavo 1765) and on the play of "The Tempest," and the notes upon it exhibited in that edition. In case I should ever be tempted to collect and publish my own little juvenile scraps of poetry, I will print Mr. CRANCH's poem with them, and his notes on the Tempest shall not be lost to the lovers of SHAKESPEARE.

* His relations, I have understood, are chiefly in America; I think Mr. ADAMS, the Vice-President, and Mr. CRANCH, Chief Justice of one of the United States, are his uncles.

Sir

Sir GEORGE YOUNG to Mr. LAMB.

“ My good Sir!

Formosa, 19th January, 1792.

“ Your very obliging letter has but just reached me at this place.
“ As soon as I can get to town again, I will most certainly pay every
“ attention to Mr. LANGWORTHY’S contrivance.

“ I think a trial should be made of some large nails at Sierra-Leone,
“ as, in every part of Africa, iron becomes more rusty than in any
“ other part of the world. *Even the keys in my own pocket were eaten*
“ *through with it in half a year’s time.*

“ Your’s, &c.

“ G. YOUNG.”

From this letter the reader sees, incidentally, a remarkable fact, in proof of the rapid decay of common iron in Africa; and the certificates from the Liverpool merchants, of the experiments made on the prepared nails, used in their ships trading to that part of the world,* shew how completely they remedy that disadvantage.

These are the most severe experiments that can possibly be made; for, not only have the prepared nails resisted the African air, acting on their heads, from three to nine months together each time, without the least

* See page 95 and seq.

visible effect; but also to the auxiliary corrosive powers of sea water, and of verdigris, (produced by the action of sea water, upon copper placed contiguous to them) constantly washing over them;—to the united operations of all these assailants, have they bid defiance for three years, save two months; (viz. from September 1789, when they were driven into the ship Bud, to July 1792, when the sheathing, being worn out, was stripped) and are now, in perfect preservation, driven into new sheathing to engage all those powers over again.

So honourable and respectable a body of evidence, as that now before the reader, will, it is presumed, sufficiently prove the reality and certainty of the anticorrosion principle, and the asserted advantages of the prepared iron, and its applicability to naval purposes, beyond any other combination or substance at present known to the world. To which I can very confidently add, that I have improved the manufacture, since the experiments I have mentioned were made, in so essential a manner as to render it ten times more capable of resisting corrosion than it was at that period.

It remains for me now to consider its uses and advantages in general, which I shall do under distinct heads, as follows:

1st. In application to bolts, nails, rudder-works, sheathing, and other metallic works for ships, *with observations on the mischiefs and disadvantages of copper in these articles.*

2

2dly

2dly. To musquets, carbines, fuses, pistols, &c. for the army, militia, marines, &c. as well for home as foreign service;—*with some interesting remarks on musquets.*

3dly. To culinary and other vessels necessarily made of metals;—*with observations on the poisonous effects of brass and copper in those articles.*

And, 4thly. To architecture, engineering, manufactures in general, and all other purposes not comprehended in the three first heads;—*with some reflections on the means and political advantages of giving it general effect.* First then,

CONSIDERATIONS ON THE USES AND ADVANTAGES OF THE APPLICATION OF THE ANTI-CORROSION METAL, TO BOLTS, NAILS, RUDDERWORKS, SHEATHING, AND OTHER METALLIC WORKS, FOR SHIPS.—

With observations on the MISCHIEFS and DISADVANTAGES OF COPPER in these articles.

THE metallic works of ships, to be as unexceptionable as possible, should be sufficiently hard, strong and tough, to withstand the most violent shocks and strains, that ships receive in storms, and should not be subject to corrosion. This state of perfection, in these articles, has never yet been reached. The metals at present used for them are either iron,

iron or a mixed metal, commonly *called* copper, of which copper is only the basis.

Great and inevitable disadvantages attend the use of either, and it is difficult to decide which, in its operation, is the most objectionable.

Iron bolts, nails, &c. when a ship, in which they are used, is not sheathed with metal, by rusting in the wood, are impaired in strength and become so difficult to be drawn, that it is very troublesome and expensive to repair ships, in which they are used; and premiums have been offered for the invention of ingines to extract them. And, when they are used in ships, sheathed with copper, the action of the corrosive acid, extracted from the sheathing by the sea water, exerts itself on them so violently, that they are soon destroyed, and many terrible accidents have resulted from this fatal imperfection. On the other hand, the experience which our navy has already had and (if every ship in it is to be sheathed with copper) unquestionably will have, *demonstrates* that bolts, nails, and rudder-works of copper, or of mixed metal, are not equal to the shocks and strains which these articles must undergo in heavy seas;—They are not only deficient in hardness, strength and toughness; but, where the timbers and planks are not perfectly dry, or the least moisture comes in contact with them, they corrode so fast and destroy those timbers and planks so rapidly, that in a very short time they get loose, and the ship, upon a strain, becomes

in the utmost danger of foundering, or the rudder-works give way, or the stern posts start, and the ship becomes ungovernable.

There never were so many losses of ships known, as within these four or five years, and their numbers are increasing every winter. In the last winter, it was particularly distressing to look into the daily papers, on account of the columns that were almost wholly filled with accounts of shipwrecks.

On the 8th of January last, it was said that more money had been lost, by sea insurances, in the part of the winter that had then elapsed, than the oldest underwriter at Lloyd's ever remembered in any winter before. Two hundred thousand pounds had then been lost on ships wrecked on the English coasts only.

In "THE TIMES" of the eleventh of October, an interesting paper was inserted, describing, circumstantially, the loss and presumed loss of divers noble ships, with rich cargoes and innumerable passengers, officers and seamen, and the imminent peril and difficult escape of many others—all in consequence of the loss or disability of their rudders; an accident which, it seems by all accounts, nothing but other rudders, in the place of those lost or disabled, can effectually supply.*

* Whether the contrivance of Mr. De Lolme, (the ingenious author of that admirable work, "A Treatise on the English Constitution") or any subsequent contrivances to prevent or remedy those misfortunes, have proved effectual or not, I am not aware.

In this catalogue are,

The Foulis East-Indiaman,
 The Centaur of 64 guns,
 The Rammilies of 74,
 The Hector of 74,
 The Glorieux of 74,
 The Johanna of Stockholm,
 The Nancy, from London to Antigua,
 The Essex East-Indiaman,
 The Hector, from London to Jamaica,
 The Birmingham, from Bristol to New-York, (with hardware, value
 40,000l.)
 The Ipswich of 60 guns,
 The Grafton of 68 guns,
 The Neptune East-Indiaman,
 The Bienfaissant of 64 guns,
 The Boreas frigate,
 The Ceres from Quebec to Aberdeen,
 The William and Mary, from Philadelphia to Amsterdam,
 An Ostend ship,
 The Aurora frigate, with Governor VANSITTART and other persons
 of distinction,
 The Swallow packet,
 The Cato of 50 guns, and
 The Cruiser, a King's cutter, from Lisbon to Gibraltar.

Although,

Although, in the cases here enumerated, it became known that the misfortunes which happened to these ships were occasioned by the loss or disability of their rudders, yet it was entirely owing to very extraordinary circumstances, such as the ship's sometimes happily surviving the storm, and being accidentally picked up by other ships, and at other times by the fortuitous escape of some sailor or passenger; but as, when these accidents happen, the ship becomes immediately fixed in one spot, without being able to make way to any place of safety, but inevitably lies, with her broadside athwart the wind and sea, 'till strained to pieces and totally lost, it oftener happens that she is never heard of more.

No less than nine among the ships in the above list, that were copper worked, appear to have met with their respective accidents, in the months of October, November, and December, 1791; a period at which the ill effects of their copper works, (according to the opinions advanced in this essay) must have been most prevalent, and rendered them most fatally apt for destruction.

Having introduced these melancholy facts, I shall attempt to account for the losses of ships' rudders in general, so far as the topic has relation to the subject and intention of this tract.

Soon after copper-bolts and rudder-works were introduced, it was discovered that they did not possess a sufficient degree of stiffness, and
that

that the rudder-works bent and twisted by the force of even a moderate sea. The copper furnishers, by endeavouring to remedy this evil, have fallen into a greater; for, by mixing other metals with the copper in order to harden and stiffen it, they have rendered it brittle, and, consequently, more liable to break by a shock than it was before. On this account, a heavy sea snaps in pieces the rudder-works, which hold the rudder to the stern-post, or, breaking the fastenings of the stern-post, carries away the rudder, stern-post and all; as, it particularly appears by the account given in *The Times*, just mentioned, was the case with *The William and Mary*. In short, as there never were so many accidents of this kind before the use of copper in shipping, it is clear, both from the fact and the argument, that these extraordinary losses can only be imputed to the objected improper use of this metal.

If we resort to chemical principles, we find the most decisive confirmation of what has been advanced.

DoCTOR WATSON, in the fourth volume of his *Essays*, proposes the following problem:

“ If the fact should be once well established, that ships, sheathed
 “ with lead or copper, will not last so long as those which are un-
 “ sheathed or sheathed, only with wood, it would be a problem well
 “ deserving the consideration of chemists, to enquire into the manner,
 “ how a metallic covering operates in injuring the construction of
 “ ships,

“ ships, and whether that operation be exerted on the iron bolts or on
“ the timbers of the ships.”

I answer thus: that a metallic sheathing must inevitably injure the whole construction, but copper perhaps ten times faster than any other metal.

“ Copper is the most liable to corrode of all the metals; for all kinds
“ of salts and all unctuous bodies, in short, every thing in nature, is a
“ solvent for it; if only exposed to a moist air, it readily acquires a
“ green rust, and even water, in time, will dissolve it.”*

Copper is acted on by other bodies, and acts on them, in proportion to the affinity it has with them, or the acids they contain.

Sea water contains an acid that dissolves copper with great facility—the produce of this solution is verdigris, which contains an acid that is, perhaps, a compound of marine and vitriolic, which is a most powerful menstruum for dissolving iron. Thus, when it was the practice to sheath ships with copper, which were bolted with iron, the verdigris produced, by the solution of the sheet of copper, in the sea water, destroyed the iron bolts and rudders' irons under water, with a rapidity never before known, and, unless it had been seen, scarcely to be credited.

* Dictionary of Arts and Sciences. Art. Copper.

The principle on which this operation is performed, according to the best informations of philosophy, is this. Iron has more affinity with the acid contained in the verdigris (or solution of copper) than the copper has, and when this acid comes within the attraction of the iron, it quits the copper to unite with the iron, and destroys it in the operation: so that in the case of copper sheathing being placed in ships whose bolts were of iron, both the metallic substances were destroyed by the two concomitant operations.

Copper, from its reception of all sorts of menstrua, (for every other metal has its peculiar solvent) has been ludicrously called by the chemists "*meretrix publica*," a common prostitute,* and—to continue the metaphor—in as much as she is ever ready for the reception of all menstrua, when in a *sound and healthful* state; so, when *disordered*, (i. e. corroded) she communicates disease and destruction to every body that has *any thing to do with her*.

A small quantity of verdigris is a certain dissolvent of the human frame, and the most trivial proportion of it is highly pernicious. A solution of one single grain of copper, in spirits of sal-ammoniac, will tinge with blue more than 256,000 times its own bulk of clear water, and render it deleterious.

* Dictionary of Arts and Sciences. Art. Copper.

It is also destructive of all fibrous and ligneous substances: one grain of it in solution, diluted with a sufficient quantity of common water, will burn the surface of a square foot of unstained leather to a blackish hue, and its operation on timber is pretty nearly as violent. Thus, when it was the practice to use iron bolts and works in copper-sheathed ships, the iron, having more affinity with this acid, than either the copper or the timbers of the ship, was attacked by it so violently as to be destroyed by it with that incredible rapidity that has been before mentioned.

In that case, perhaps, the copper sheathing did not injure the timbers of the ship, in any very considerable degree; but, since the iron has been removed, and copper bolts and works have been substituted for it, the verdigris has nothing near it of any affinity with it but the planks and timbers of the ship, and consequently now exerts its corrosive powers, and burns and destroys them, as rapidly as it before did the iron:—Nor is the injury the planks and timbers of the ship receive from this operation all; for the bolts, nails, and other fastenings, get loose and infirm in their places, and render the ship liable to strain and founder; and if the bolts and nails, that hold the stern-post or its fastenings, do not break, they will draw* with much more facility than they were

* It has often happened that they have been drawn with the mere rolling of a ship; and it has been frequently found, that the planks of our men of war have been destroyed by the copper sheathing and nails in little more than a year.

driven

driven with, and then, agreeable to the common sea phrase, "farewell, rudder; farewell, ship."

It is upon this principle that walking canes are stained. The operation is performed thus: The manufacturers of these take a small quantity of vitriolic acid, put it into a tea-cup, and dilute it with eight or ten times its quantity of water. With this acid they wash the cane all over, then take some pot-ash and water (already for the purpose mixed in a sort of paste) and with their fingers sprinkle it over the cane. Wherever the pot ash falls, the acid, having more affinity with the alkali than with the cane, will quit the wood and unite with the ash; those parts of the cane, therefore, where the ash falls, retain their natural hue, or are only a little discoloured; and where it does not fall, the acid, having nothing to unite with but the cane, attacks and burns it black, brown, red, &c.

So the acid, produced by the solution of copper bolts, nails, sheathing, &c. in sea water, destroys the timbers and planks of a ship; because, there being no iron, the verdigris has nothing to attach itself to of nearer affinity than those timbers, planks, &c.; upon which, therefore, this ever-mischievous solution begins and continues to prey, until those destructive and fatal effects follow, that have been before described.

Among these effects, it is of material consideration too, that though a ship, whose metallic works are copper, should escape foundering from

the causes assigned, as resulting from the use of that metal; yet, when she comes to repair, if the timbers were not perfectly dry, or retained any of their vegetable juices when the ship was made, the bolt-holes, &c. will be found to be so burnt by this eager acid, that the holes must be bored as big again as at first, or new holes bored before she can be new bolted, which must certainly weaken the ship, to say nothing of the additional expence of enlarged bolts, if the old holes are bored anew.

It has been frequently observed, since it has been the practice to sheath with copper, as well for the purpose of fast sailing, as for defending the ships bottom from worms, &c. that sometimes the copper will last four or five years, and at others not a third part of that time, which has been considered by many to be very mysterious.

To me, however, it seems that there is little difficulty in accounting for this. In the first place, there is a great difference in the qualities of the copper of different countries, and of different parts of the same country, in weight, density, ductility, and liability to corrosion;* and a great deal depends upon the perfection of the processes of smelting and rolling. In case the copper be incompletely smelted, before it is sent to the rolling or flattening mills to be rolled into sheets, or if in un-

* I am now speaking of mere copper, not the base mixture of late in use for sheathing.

dergoing.

dergoing this last operation the copper (as is too commonly the case) be heated very hot, in order to pass the more easily between the rollers, the sheets are ~~apt to be~~ porous, and of course the metal is ^{apt to} the reception of its various menstrea; but when the copper has been perfectly melted, and is passed entirely cold, or but slightly heated, between the rollers, the increased number of times necessary to reduce it into sheets condenses it, renders it less porous, and of course enables it to sustain the action of sea water better than that which has been wrought after the former manner. But probably the chief reason is this:—There is an acid which seems to be universally diffused throughout nature for its preservation from putrefaction. This is most plentifully found in that vast body of water the sea; and as heat promotes putrefaction faster than cold, it follows that a greater quantity of acid is necessary in hot than in cold climates; and it seems to be wisely ordained by Providence, that the sea is impregnated with this acid more or less in proportion to the degrees of heat or cold it is to suffer; accordingly, sea water becomes gradually more salt, as it approaches the equinoctial line, and vice versa.*

It

* This is the doctrine of Mr. BOYLE. Subsequent pursuers of philosophy seem to have ascertained, that sea-water is not the most strongly impregnated with salt, precisely at the Equator, but where the sun is vertical, in which situation probably is wholly saturated.

Dr. IRVING, when he accompanied the late Lord MULGRAVE in his *frozen* expedition towards the North pole, with a view to discover a passage that way to India, ascertained that in
latitude

It has been discovered that a pint of sea water in the Mediterranean contains an ounce of salt; that the same quantity of water in the Baltic contains

latitude 80, near the ice, the water contained not one thirtieth of salt. And in a voyage to the Cape of *Good-Hope* it was discovered that near the island of St. Jago, by St. Nicholas, it contained one-fourth of salt.

These and other experiments confirm the doctrine of Mr. BOYLE; and, in deliberating on this wonderful œconomy of Providence, a thought has struck me, which, if it should turn out to be a just hypothesis, may be of sufficient importance to Europe to claim its notice; I shall not, therefore, apologize for digressing to a note on a subject so foreign to the design of this tract, as the following may, by some, be considered to be.

If the use of salt in nature be to prevent putrefaction, and if heat be more capable of producing putrefaction than cold, it should seem that all matter susceptible of putrefaction, as well animal and vegetable, as aqueous and aerial,* must have a larger portion of salt in its constitution to guard against this destruction in hot, than in cold climates. Hence probably the reason why the vegetable productions of a cold, cease to exist in a warm climate; and hence also the reason, why so many thousands of Europeans, who venture on the shores of India, so speedily fall victims to malignant *putrid* fevers; for, if the sea and air require six or eight times the quantity of salt on the Asiatic, more than on the European shores, to preserve them from putrefaction, why should not animal bodies require a similar increase of that ingredient, as a necessary constituent to a similar preservation?

* I say aerial, for it appears clearly, by the fact mentioned by Sir GEORGE YOUNG, page 112, that the air at Formosa, must have contained at least eight or ten times the quantity of the universal or some other acid, than the air of England does. What elfe could have corroded the keys in his pocket, in so rapid a manner?

Would

contains only half an ounce; and that a pint of water of all the seas near the Equator contains from three to five ounces of salt: and the more the water is impregnated with salt, the faster will it dissolve the copper;—hence, it follows, that the copper sheathing of a ship will last as long again in the Baltic as in the Mediterranean; and from four to eight times as long as in the Southern part of the Atlantic, the

Would not daily bathing in warm baths of sea water, or water and salt, while on the passage, and on landing repeating it frequently on shore, infuse into the constitution more than the usual quantity of salt? or can it be done any other way? And if so, might not such a supply of salt enable Europeans to support the heat of the Asiatic climate, and preserve them from the attacks of this malignant disorder, which has hitherto bid defiance to all medical art?

Would it not be worth while to endeavour to discover, whether the blood and juices of the body can be speedily salted, by such bathing, or by any other mode?—To any ingenious physician, inclinable to make such experiments, I give the following hint:

Let a pint of blood be taken from each of a few individuals, and the quantity of salt each pint contains be ascertained;—and let similar experiments be made on their urine.—Then let them use the warm salt baths for given periods of time, and afterwards repeat the experiments, to discover if the like quantities of blood and urine contain a larger quantity of salt than at the making of the former experiment.—If it should turn out that the salt can be, by this process, infused into the constitution, the idea may be worth the paper, which I shall, otherwise, have wasted upon it. Does the blood of an African, &c. contain more salt than that of a European?

I see vast utility that may arise from such experiments, even at home, provided my hypothesis be just, but I cannot here enlarge upon them.

Ethiopian

Ethiopian sea, the Southern and Indian oceans, or the tract from the South seas to the Pacific ocean. So that the same sheets of copper will corrode as much, and do as much mischief to a ship, in one voyage to India or Gaudaloupe, &c. as they would do in six or eight years to the same ship in cruising the British ocean or sailing up the Baltic.—Hence the reason why the sheathing of the Queen East-Indiaman, mentioned in the note, page 60, was so wonderfully wasted in one voyage;—hence the loss of the Foulis;—and hence the train of misfortunes that have attended our Indiamen and other foreign trading ships, since the use of copper in ship-building. So that, as the Teredo worm abounds most in hot climates, it unfortunately happens that *copper* sheathing is least serviceable, where a metallic sheathing is most wanted. Indeed it frequently happens, that, when the sheets get thin, this destructive worm actually bores through them, and attacks the ship with as much facility, as if it were sheathed only with wood, or payed over with rosin, pitch, &c.

From these circumstances, instead of any advantages being gained by the adoption of copper bolts and works, in preference even to common good iron, the contrary seems to be the case—and if lead sheathing were discontinued, on account of its injuring the iron works of the ships, how much more necessary is it, that copper, which appears to be, not only deficient in strength and subject to corrosion, but also to be eminently dangerous to the whole structure of the ship, should be immediately abolished!

As

As a succedaneum for copper sheathing, I propose a new metallic compound sheathing, of which lead is the basis; which in the first cost will be rendered cent per cent cheaper than copper; and for copper bolts, rudder-works, &c. I propose my anti-corrosion iron.

With respect to my proposed metallic compound sheathing, I offer to sustain this proposition, that it is as tough, as strong, and as smooth, as copper, and *five* times less liable to corrode; and with respect to my anti-corrosion bolts, nails, rudder-works, &c. I offer to sustain this proposition, that they are as strong, if not stronger; as tough, if not tougher; more durable, and less liable to corrosion, than any made of the best iron, and considerably stronger, tougher, lighter, and infinitely less subject to corrosion, than any made of copper or mixed metal.

Both my bolts, &c. and sheathing, having equal affinity to the acids contained in sea water, they will not injure one another: and I offer to prove that both of them, being less liable to corrode than any yet brought into use, will proportionably less injure the construction of the ship; for in the composition of them, I have proceeded accurately upon the proposition laid down in page 69, and have, I think, come as near to it as possible: I have a method also *of laying on* my sheathing, from which advantages superior to any as yet in practice, may be derived, whenever brought into use.

My anti-corrosion bolts and works are not liable to any of the objections made to iron or to copper—for, by remaining unimpaired, they are drawn as easily as driven; and, as they neither diminish in themselves nor injure the timbers, they remain tight in the ship. They are preferable then, to iron, inasmuch as they do not fix themselves in the timbers of the ship by rust, so as to be incapable of being drawn when it becomes necessary; and they are preferable to copper, inasmuch as they do not diminish in themselves, nor corrode the timbers, and by these means get loose; and inasmuch as they are so strong and tough, that the most violent strains that a ship can bear, will not break or bend them; while a trifling sea will twist and snap copper or mixed metal ones to pieces.

I therefore offer my metallic works to supercede copper, for all the purposes to which copper is applied in ship-building, and to shew the saving that will be made, by the substitution, I submit the following calculation and comparison on one ton of each.

A CALCULATION OF THE DIFFERENCE IN THE EXPENCE OF PREPARED
IRON AND COPPER, FOR SHIPS BOLTS, RUDDER-WORKS, &c.

The original cost of a ton of prepared iron bolts	£.45 0 0
	Supposing

	£.	s.	d.
Brought up	45	0	0
Supposing a ship to be broken up in fifteen years, there is the interest of 45l. for that time to be added, say at 5l. per cent. which is	33	15	0
Total	78	15	0

Now supposing that my bolts are not corroded in that time, they are worth 15l. to be prepared anew.

But supposing that they should be corroded, and are worth, as the Navy Board state* as old iron, only.....	10	0	0
Then deduct that drawback of 10l. from the 78l. 15s. and the cost of a ton of prepared iron bolts is.....	68	15	0

The original cost of a ton of copper bolts is..... 112 0 0

The specific gravity of copper being equal to one sixteenth more than that of prepared iron, it will require 40lb. of copper to be added to the ton, to make the same number of bolts (and of equal dimensions) as were made out of one ton of iron.

There therefore remains to be added for the additional 140lb. of copper, at one shilling per lb.....	7	0	0
Total	119	0	0

* See page 87.

	£.	s.	d.
Interest of 119l. at five per cent. till the ship be broken up, viz. for fifteen years	89	15	0
Total	208	15	0

Supposing that by the natural waste of the copper in the ship, and by the clipping and thefts of the workmen* in driving and drawing, only one-third of the copper is wasted, then there is a drawback on the two-thirds of the ton of copper, at nine-pence per lb. to be deducted from the last total.....	59	6	8
---	----	---	---

So that the final expence for a ton of copper bolts is.... 148 9 8

While that of prepared iron is only..... 68 15 0

The difference in favour of the latter is therefore upon this calculation, <i>per ton</i>	79	14	8
--	----	----	---

In order to shew the aggregate importance of the saving that will be made by the adoption of my prepared iron bolts, &c. as a succedaneum for copper for ship-building, &c. I shall give the following table, containing the number of bolts driven under water in a seventy-four gun ship, their diameters, weights and lengths, and then offer

* For this see pages 58, 60, and 91.

a calculation to shew the saving that will be made in the whole navy of Great-Britain.

	No.	Diam.	Weight.		
		Inch.	Tons.	Cwts.	Qrs.
In the scarps of the keel and stern.....	60	1 $\frac{1}{4}$	0	3	0
In the deadwood, floors and keelson.....	80	1 $\frac{1}{2}$	1	4	0
In the orlop knees.....	260	1 $\frac{1}{4}$	1	7	0
In the riders	380	1 $\frac{1}{2}$	2	16	0
In the hooks, crutches, and stops.....	90	1 $\frac{1}{2}$	0	16	0
In the sleepers.....	60	1 $\frac{1}{2}$	0	5	0
Butt ends and bolts in the bottom.....	600	7 $\frac{1}{2}$	0	15	0
In the knee of the head.....	8	1 $\frac{1}{2}$	0	5	0

The weight then of the iron bolts driven in
a seventy-four gun ship under water is.....

7 12 0

And as the saving on the use of a ton of prepared iron bolts, instead of a ton of copper, is 79l. 14s. 8d. the saving on the bolts driven under water in a seventy-four gun ship will be, if I have calculated right 742l. 14s. 8d.

My sheathing is of the same price as my
bolts, nails, &c..... } or £.45 per ton.

The

The navy of Great-Britain, comprising ships of the line, fifty-gun ships, frigates, sloops, &c. consists of four hundred twenty-three sail, all of which, it seems are to be sheathed, &c. with copper. Now supposing all these ships consumed as much copper as two hundred and fifty seventy-four gun ships—then, if my bolts, &c. be adopted in the navy instead of copper, the saving on bolts under water* would be 187, 762l. 1s. 5d. And supposing that only as much more is used in nails, rings, sheathing, rudder-works, &c. the saving would be 375, 524l. 2s. 10d. The annual saving of interest and repairs will be equally considerable: and as this prepared iron has a superiority over copper in strength and permanency, and more than cent. per cent. will be gained on the change, merely on the first cost; it must, upon the clearest dictates of reason and truth, be altogether preferred to copper. Nor is what the publick and merchants will save, in the original cost, the only advantage to be derived from the adoption of this manufacture; for the bolts, nails, &c. upon the breaking up and repairing the vessel, may be used over again, so that the whole of a second expence, deducting wear and tear, will be saved.

Besides all this, a most material advantage is gained, in repairing or heaving down ships on foreign stations; for, by the use of the same unimpaired bolts and nails, the necessity of new ones, and of setting up forges on shore, is done away, and much labour, time, and expence, saved.

* Copper bolts are *as yet* in general only used in those parts of the ship that are to be under water.

It has been shewn, that the weight of iron bolts driven under water, in a seventy-four gun ship, is 7 tons, 12 cwt. and that an additional weight of 140lb. per ton of copper, is necessary to make as many bolts as the iron; it therefore appears, that the weight of copper bolts, driven under water, in a ship of the same size, must be 8 tons, 1 cwt. 24lb.; and computing, as I have before done, that it takes the same quantity to sheath and nail her, &c. &c. the quantity of copper used in a seventy-four gun ship, is 16 tons, 3 cwts. 1 qr. 20lb. which, in the whole British navy, is upwards of 4,000 tons, or more than sixteen million pounds weight.

If therefore copper be abolished in the navy, perhaps 2,000 tons might be procured from thence to supply the brass-makers; the sale of which would pay for supplying its place with the anti-corrosion manufacture, and leave a balance of nearly 100,000l. in the hands of government.

I offer my bolts and nails, and recommend them, for all kinds of shipping, and most particularly my nails for deck-nails, and for nailing on wood sheathing.

The common iron nails, that are driven into the wood sheathing, are, in warm climates, destroyed in one year, and I think I may venture to warrant mine to last six, perhaps twelve years.

But

But suppose they only last three, (and that they will do so has been proved) the saving will in this case be richly worth attending to, exclusive of the dependance on them in performing any voyages.

They are also most important for clencher-built vessels of every sort.

It was long ago a maxim, well known to every ship-builder, sailor, and merchant, concerned in shipping, that a clencher-built ship or vessel would sail much faster, and be much more buoyant on the water, than a carver-built one: yet it is not the practice to build clencher vessels but for particular expedition, such as packets, smuggling vessels, &c.

This being so well known, every man, who has not thoroughly investigated the nature of ship-building, will naturally ask why it is not universally adopted? The answer is short and simple: Great as the advantage apparently is, and must be, in favour of the clencher-built vessel, as well for expedition as for burthen, the expence of *repairing* is more than equal to the advantage; for the heads and bodies of the nails, in a clencher-built vessel, being more exposed to the air and sea water, than in a carver-built one, corrode and destroy both themselves and the wood so fast, that they seldom last above two or three years; by which time the vessel gets leaky, and wants a thorough repair or entire new planking; and by this time the nails and bolts are so rusted in the timbers, that they cannot be drawn without dangerously

rously shaking the whole structure of the ship. The prepared bolts and nails completely avert this disadvantage: They neither decay in themselves, nor destroy the timbers; with them those who prefer the clincherbuilt vessels, may now build after that mode, without the least dread of being put to the expence of repairing, while the timbers and planks last; and even when the planks are worn out, and the vessel requires new ones, the same nails will serve again, as has been demonstrated in the cases of the vessels called the Bud and the King Grey.

Under all these circumstances, I trust, nay, I am flattered to hope, that the governing powers of this country will not delay to do justice to the public, by proceeding seriously and immediately to ascertain the truth of what I have alleged, upon subjects that in themselves are unquestionably of great political and national importance.

My education and habits of life not being well adapted to the employment of superintending a manufacture, I must beg permission to add, that I have formed a Company, called the LONDON BLANCHED IRON COMPANY,* for the purpose, whose address is added to this tract; and if, upon revision and further consideration of the subject, the Lords of the Admiralty should be of opinion, that the experiments I have here

* Since the antecedent part of this work has been printed off, I have thought "*Blanched Iron*" more adapted to the comprehension of the people than Anti-corrosion Iron; and have therefore substituted that term for anti-corrosion; though, for the sake of uniformity, I shall continue the term through the rest of the tract.

published are sufficient to prove that the use of my nails will be advantageous to the navy, the said COMPANY are ready to contract with the Right Honourable Board to supply their wants with all possible expedition.

I proceed now to the secondly proposed head of consideration, namely,

OF THE USES AND ADVANTAGES OF THE PREPARED IRON IN APPLICATION TO MUSQUETS, CARBINES, FUSEES, PISTOLS, &c. FOR THE ARMY, MILITIA, MARINES, &c. AS WELL FOR HOME AS FOREIGN SERVICE;

WITH SOME INTERESTING REMARKS ON MUSQUETS.

IT is well known, that a great deal of the soldier's time is, at present, necessarily taken up in *cleaning* his arms, and that in warm and moist climates, and in the sea air, in sudden action or in long marches, fire-arms, when most wanted, are too often found useless on account of rust, which it is not in the soldier's power to prevent. At home, in our armouries, the cleaning of arms is the sole business of many men, with salaries and perquisites, and still the arms become unserviceable and wear out by mere cleaning. The permanent preservation of them, in a sound and clean state, by the *anti-corrosion*, would consequently operate a considerable saving. When in use, at sea or in the field, a little chalk and a woollen cloth, only, are necessary to keep them *bright*, as well as *clean*.

It

It is the practice of the soldiers, when they clean their musquets, to take the barrel from the stock, and, holding one end in their hands and resting the other on a table, to rub the barrel with the ramrod, the bayonet, a piece of brick or a stone, hard enough to get off the rust. The method of the marines, indeed, is far worse than this: They fasten two loops to the beams under the half deck, so as to receive the two ends of the barrel, throw a rough brick-cloth over it thus suspended, and, holding one end of this brick-cloth in each hand, rub or rather grind the barrel with all their force and weight. This treatment inevitably warps the barrels, while it wastes the substance of them; and it has long been observed by military men, that if you give a regiment new arms to-day, and they have frequent occasion to clean them, they become so warped in a month, by those violent and uncouth operations, that scarcely twenty musquets in the regiment will hit a man at the distance of twenty yards; and it is probably more from this cause than any other, that (according to the renowned Duke of Marlborough's observation) not more than one bullet in two thousand does execution in battle, and that the arms of the marines are spoiled so much sooner than those of other military corps.

In newly-raised regiments, the *locks*, also, are spoiled by the inexperience of the men, who, when they have taken them to pieces and cleaned them, find it difficult to put them together again. To remedy these inconveniences, a great deal of trouble has been taken, by the present noble and intelligent Master-General of the Ordnance, whose

attention to the duties of his important station, and to all who can suggest any publick improvement, it is justice to acknowledge. Mr. Nock, of Ludgate-hill, has been for some time constructing, under his Grace's direction, a very curious lock, which has not a screw in its whole fabrication, but is kept together by the pressure of one spring acting upon another; the whole being ingeniously confined within the plate of the lock, and, when this lock is taken to pieces, it is impossible to put it together again but by the right way.

The united ingenuity of the Dukes of YORK and RICHMOND has also given rise to a variety of improvements of the musquets to which those locks are to be placed. To teach the soldiery to level well, is one of the greatest difficulties the military officer meets with; and, to surmount it, the Duke of YORK has so contrived the firelock, that the soldier, holding it by a particular convenient part, which it is difficult for him to avoid, cannot, but by wilful design, lift the piece to his shoulder without its two ends being instantly so equipoised as to give it its proper level. By this newly-constructed lock then, by this capital improvement to facilitate and secure a correct level, and lastly, by the adoption of my preparation of the barrel to keep it from rusting, and consequently from being warped and wasted by scouring, many very material inconveniences will be avoided and done away.

The anti-corrosion is also especially applicable to the lock-pan. In common musquets the pans of the locks, by frequent firing, and want
of

of cleaning, are so corroded by the nitrous acid left by the powder, that the rust frequently choaks the touch-hole, which in a short time also corrodes, and the piece is rendered useless.

The advantages of the anti-corrosion would be particularly manifest in Asia, Africa, and America, where iron, from the causes already assigned, corrodes much faster than in Europe; though, with respect even to Europe, I have been informed by some officers, who served in the Irish brigades, with the Austrians, against the French, during the last campaign, that, towards the end of it, not one musquet in an hundred would go off for days together, they were so injured by rust; and the French arms are said to have been in a far worse state than these.

I might have made a considerable advantage by going to France, to prepare the French arms, this winter; but, as I thought, from the appearance of things, that we should be involved in a war with that people, I could not (as I had the honour to acquaint Mr. PITT) think of sharpening a poignard, which, I apprehended, might shortly be aimed at the bosom of my country: and therefore I declined the expedition.

The advantage which an army, whose musquets the most violent and continued rains and damps will not affect, must have over one whose whole power may be impeded by a single shower, is, I should think, too great not to be coveted by every soldier; and, I would hope, that
the

the Powers intended to be combined to check the progress of French mischief, will not pass a campaign, without availing themselves of some of the advantages held forth by the anti-corrosion manufacture.

I therefore quit this topic, and proceed to the third proposed head of consideration, viz.

CONSIDERATIONS ON THE ADVANTAGES OF THE ANTI-CORROSION
IRON WARES, PECULIARLY PREPARED WITHOUT THE LEAST CON-
TAMINATION OF COPPER, BRASS, OR LEAD, FOR CULINARY AND
OTHER VESSELS NECESSARILY MADE OF METAL.

WITH OBSERVATIONS ON THE POISONOUS EFFECTS OF BRASS, COPPER,
AND LEAD, IN THOSE ARTICLES.

BESIDES the extravagant exportation and wanton consumption of copper, in the modes which I have exposed and reprov'd, in former parts of this tract, both copper and brass are perniciously misused in making vessels for cookery, pharmacy, &c.

By this practice, ~~although~~ universally condemned, yet universally continued, our healths are constantly in danger, frequently injured, and frequently destroyed. The unanswerable reasonings of philosophy
have

have in vain attacked it; all the eloquence of philanthropy has been thrown away in pathetick diffusions from it; ten thousand morbid miseries, and death itself, have failed to frighten us out of it; experience has as ineffectually proclaimed its dangerous effects in every village, street, and alley of the kingdom! There is at this time hardly a tavern, coffee-house, or private family, but has its pots, kettles, sauce-pans, stew-pans, pickling-skillets, milk-pans, &c. of this metal, or its compounds, brass and pot-metal.

Respecting the deleterious effects of these metals, where solutions of them have been communicated to aliments, some of the most curious facts that I am acquainted with, have come within my own immediate knowledge and observation. But as no one will attempt either to resist so dreadful an army of facts as is already extant on this topick, or to qualify the force of their application, I shall silently pass them all, under an ardent hope, that the practice of dressing food for the human species, in vessels pregnant of acute poison, will no longer tarnish the boasted mental lustre of the eighteenth century.

~~It appears by sacred history, that metallurgic chemistry was in a pretty eminent degree understood before the flood. For in Exodus, we find TUBAL CAIN celebrated for fabricating iron and copper for domestick purposes. Whether the art was lost at the deluge, does not so plainly appear; but, supposing it were, it seems to have been speedily revived, for we read in Deuteronomy, that MOSES burnt to powder a GOLDEN calf.~~

The

The use of copper, ~~however, even~~ in England, is of very long standing. The discoveries of antiquaries, as well here as in other parts of Europe, have evinced, that it was the metal first used for warlike weapons, and it is highly probable, that it was also the first used for culinary purposes, because, as it is often found in a pure metalline state, it was more easily moulded into the necessary forms for such purposes than any other; and no doubt thousands fell sacrifices to the use of it, in culinary purposes, before it was supposed to be attended with danger. When this danger was discovered, and men advanced in the science of metallurgy, they were put upon the idea of what is called tinning the inside surface of the copper vessels,—a practice which may fairly be supposed to be derived to us by the Romans, in the time of their dominion and colonization of this Island.* But the difficulty of making pure tin adhere to copper, in the present mode of tinning, is very great, and what but few, even of those who pretend to it, can effect. The metal which is now laid on by the generality of copper-smiths and tin-men, is a compound in itself unwholesome; for lead is a constituent of the composition: and from the tenuity of the coat which they lay on, even where they use pure tin, it is not sufficient to prevent the poisonous qualities of the copper from being absorbed by the meat that is boiled in them; or, grant that it completely excludes the copper, the operation of *scouring* soon wears it off, and the danger returns:—

* See page 72.

DoctOR WATSON, treating of this subject in his Chemical Essays, says,
 “ I had the curiosity to estimate the quantity of pure tin, which is used
 “ in tinning a definite surface of copper. The vessel was accurately
 “ weighed, before and after it was tinned. It’s surface was equal to
 “ two hundred and fifty-four square inches; its weight, *before* it was
 “ tinned, was forty-six ounces, and its weight, *after* the operation,
 “ was barely forty-six and an half; so that half an ounce of tin was
 “ spread over two hundred and fifty-four square inches, or somewhat
 “ less than a grain of tin upon one square inch. How innocent soever
 “ pure tin may be, yet the tenuity of the coat of it, by which copper
 “ vessels are” (and *only can be*) “ covered in the ordinary way of tinning,
 “ cannot fail to excite the serious apprehensions of those who consider
 “ it; for, in the experiment which I have mentioned, the tin was laid
 “ on with a thicker coat than in the common way: instead of a grain,
 “ I suspect that not a quarter of a grain is spread over a square inch
 “ in the common way of tinning.”

The labours of learned men who have written against this manufacture, have put the manufacturers on substituting others; but all that have yet been thought of are liable to some objection or other, so that the use of copper, with the name of being *tinn’d*, still prevails.

Though we were principally beholden to foreigners for copper and brass, we had no other metal in use for culinary vessels and household utensils (except cast-iron) till that excellent member of society ANDREW

YARRANTON, about one hundred and thirty years ago, brought the secrets of the tin-plate manufacture from Germany into England, where it came into general use about seventy years ago, as before stated.* This seems to be the best substitute for copper at present publicly known: it is perfectly innocent; yet liable to objections on other accounts, which the copper-smiths do not fail to enlarge upon as much as possible. —If it be left on the fire without water, it will be burnt through in a short time; and, if it be left damp after being used, it is soon destroyed by rust. It has been lately improved by the Pontipool manufacturers, who have made the plates much thicker than usual. To this manufacture they have given very improperly the name of “*Double Block Tin*.” Had they called it “*Double Tin-plate*,” the name would have conveyed some meaning with it, whereas at present it conveys none. This, however, is liable to the same objections, though in a less degree.

The *tinning of cast-iron* has lately been attempted for pots and kettles—but this manufacture has met with little success. The difficulty of making tin, or any other metal, adhere to cast-iron, in the usual mode of conducting the operation, is so great, that none who have yet attempted it, have been able to succeed in any tolerable degree. So thin is the coat that has been, as yet, laid on, that about three weeks use wears it completely off; and, when the tin is gone, the iron discolours every thing that is boiled in it, to so great a degree, that, as the cooks

* The French writers have given the merit of publishing the secrets of this manufacture, to the celebrated REAUMER of Paris, who, they say, discovered them by hiring himself as a labourer in the works of Germany, dressed in the mean habit of a peasant.

prefer appearances to health, this manufacture is condemned; and copper still predominates in the kitchen, if not in the nursery.

Among the higher class of people a manufacture of another kind has been introduced—copper plated with silver—commonly called Sheffield plate.

It is well known to those who are acquainted with the nature of this manufacture, that the solder necessarily used in it will produce verdigris, though not in so large a quantity as copper, yet in sufficient quantities to render the vessels unsafe;—besides, independently of the solder, the plate of silver is so surprisngly thin, that it is speedily worn off by use and cleaning; and as the silver is put upon the copper, by being cemented to it in a square piece by melted borax, and then rolled into a sheet before it is made into vessels, there is no way of applying new silver when the old is worn out, as you can apply tin, to vessels made of copper:* so that, upon the whole, the silver plated copper is at least equally objectionable with tinned copper. Indeed silversmith's plate itself produces a considerable degree of verdigris, and is unsafe for culinary uses.†

* One ounce of silver is often rolled out into a surface of about three square feet, and its thickness is about the three thousandth part of an inch.

Watson's Essays, vol. iv. p. 200.

† I have collected from a small silver salt-spoon which was in common use at table, and left to remain in the salt, when put away, near ten grains of verdigris in three months; and it had been occasionally cleaned during that time.

In 1754, the Swedish Government, in consequence of some representations of the College of Health, were so convinced of the danger of using copper vessels in any shape, that they authoritatively abolished the use of them in their fleets, and ordered tinned iron to be substituted in their stead. It is in every consideration to be wished, that all other States would follow the example, and, with respect to England, that the abolition might be extended to the use of culinary vessels in every house in the kingdom.

In the Medical Observations of the London College of Physicians, vol. ii. page 1, it appears, that the symptoms, so commonly incident to sailors, called *highly scorbutic*, are attributed to the use of copper vessels: there is particularly a very strong instance given of two hundred ships sailing from Scarborough in the year 1757, all of which, except a few, used iron pots, and those symptoms were never seen in any of the men, except in the ships where copper vessels were used. And a variety of other complaints, commonly attributed to other causes, or for which we find no cause, I have no doubt may arise from eating food dressed in these vessels, the poison of which is thereby continually *stealing* into our blood, and leading us *imperceptibly* to disease and death.*

* It appears by the works of the Gentlemen of the Faculty, who have particularly attended to the operation of this poison, that its most striking effects are, violent vomitings, insufferable itchings and burnings, sudden pains darting through the limbs, discharges of bile, inflammations, convulsions, fainting fits, delirium, palsy, and death.

It is decided by the chemists, that nothing but *iron*, *zinc*, and *tin*, are innocent for culinary vessels; some have objected to tin, and others to zinc, but it has been finally proved that these objections were without foundation.

The manufactures of tinned iron, hitherto brought forward, have fallen short of some conveniences which attend the use of copper, otherwise perhaps people would not be quite so inconsiderate as to continue its use; but I have discovered a method of enabling either a wrought or cast-iron pot to absorb almost any given quantity of a metallic mixture, perfectly innocent, and of coating the inside of both with as thick a coat of it as I choose. *Cast-iron* pots are so liable to be broken, either by a blow, or by throwing water into them when hot upon the fire, that I shall discard them from my plan, and confine myself to wrought-iron.

THIS then I propose to supersede the use of copper in all the common culinary vessels.

I will suppose that a good thick wrought-iron pot will last twenty years; I can lay on a quantity of my compound sufficient to last as long as the pot; but supposing that, by the operation of cleaning, and by constant solution in use, the coating should last only five years, then the comparative difference between tinned copper and this new manufacture seems to be this.

The

The new manufacture is in the first cost fifty pounds per cent. cheaper than copper; the vessels made of it are lighter, as clean, and, in the inside, more elegant in appearance, than any tinned copper ever made. The composition will remain on them five years, during which time they will dress meat, white and delicate.

The tin on copper, with the same use, will not last five months, or perhaps five weeks. When the composition is gone from my manufacture, it will only discolour the meat;—when the tin is gone from the copper, the meat that is dressed in them will poison those that eat it.

I now proceed to the fourth and last proposed head of consideration, viz.

OF THE ADVANTAGES OF THE ANTI-CORROSION IRON IN APPLICATION TO ARCHITECTURE, ENGINEERING, MANUFACTURES IN GENERAL, AND ALL OTHER PURPOSES NOT COMPREHENDED IN THE THREE FIRST HEADS.

THE architect cannot look at an iron rail, a hinge, a bolt, or a nail, without observing the ravages of rust; nor can the engineer observe the iron work of the locks of a canal, or of a wet dock, bridge, &c. without perceiving the advantages that must attend the anti-corrosion in these articles.

All

All kinds of sheet-iron that have yet been tried, whether pure iron or the tin-plate, are found unequal to the strong action of the acid of smoke, of water, of oils, and of atmospheric moisture and air: Instead therefore of sheet-iron, I propose my plates or sheets of anti-corrosion metal. They defy all these powers, and, among other purposes, may be advantageously applied for iron works of mills, funnels for conveying smoke, plates for covering houses and doors, and as a succedaneum for HARTLEY's fire-plates, &c. &c.

The application of them to covering houses and other buildings is considered to be of the utmost importance, having in all respects a conclusive advantage over every other covering hitherto known.

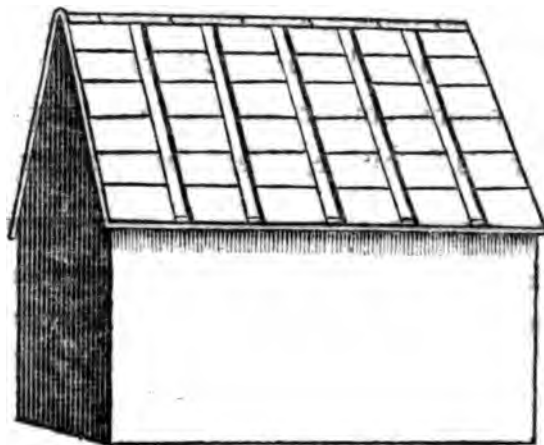
Lead is a safe and secure covering, in as much as it defends the building against the attacks of weather, better than any other hitherto publicly known, and there is no great danger of a house which is covered with it unroofing, by the attacks of violent wind; and, as it is not soluble or capable of being corroded by water or air, it will, as a covering, never wear out or decrease in weight; on the contrary, it is said that lead will increase on a building as well as in a mine. It has been said that the lead covering of a church, which had been on some hundreds of years, was heavier when taken off than when put on, as appeared by the plumbers bill. Yet there are objections to lead, that counter-balance all these advantages, (particularly milled lead;) it is liable to crack by the heat of the sun; its ponderosity will often distress
the

the timbers of a roof and the walls of a house, and frequently endanger them; and the expence of carriage is immense. Copper removes many of these objections, but the very high price of copper renders the application of it, to such consumptive purposes, exorbitantly expensive to the individual, as well as very prejudicial to the balance of trades and manufactures, and to the general interests of the state; and there is a very sensible objection to the thing itself; from the slowness of its substance, as usually applied, it is very liable to be cut and broke through by the falling of stones thrown by boys on it, and other accidents of that nature, and to admit the rain through the holes.

Iron plates are in general use in Russia and in Norway; they have also been used in some parts of England, and make a good, light, strong covering, but they corrode so fast that they are very speedily destroyed: Slate and tile are the only coverings (except thatch) in general use in any part of England: and these are liable to the greatest of all possible objections: from the manner in which only they will admit of being put on, their weight is excessive, (the tile in particular) and they are so liable to catch the wind, that a stormy day or night shall frequently unroof a church, and sometimes almost a whole town; to say nothing of the danger to life and limb, that is constantly to be apprehended, from so heavy a substance individually giving way, and falling in a thousand different directions from so great heights; the slate (especially) scattering about like so many wafers. But all objections that iron plates, and sheet lead, as well as slate and tile, are liable to, are completely

pletely obviated by the *anti-corrosion plates*. These plates are of milled iron, whose pores are impregnated and filled, and whose surfaces are coated with a composition, by which all the good qualities of lead and iron are preserved, (i. e. the strength of the iron, and the *incapability* of corrosion of the lead) while the increase in *weight* of the iron by the preparation is so small as not to be worth mentioning: One hundred pounds weight of ~~these~~ plates will cover as much as one thousand weight of slate, or fifteen hundred weight of tile, at the first laying on; and the weight of slate and tile is considerably increased every year after, by their absorption of water, contracting dirt, and producing moss, by which the roofs are endangered and frequently broken in.

The anti-corrosion plates are used without any laths or cross rafters, articles which induce a considerable expence, and are absolutely necessary in tiling and slating. These plates may be had of any length and breadth that builders choose, and may be laid on with the utmost simplicity, thus:



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The quadrangular spaces distinguished between the horizontal lines represent the anti corrosion plates, the upper ones overlapping those below. The perpendicular, or rather oblique lines, represent in perspective the narrow pieces of plate, which cover the joints where the plates meet, which joint-covers are nailed to the rafters underneath, by anti-corrosion nails driven through both the joint-covers and plates at once: and these rafters are all the timbers ~~that are~~ necessary in such a roof. The joints are all water-tight by the construction, and a cement, or (should it be preferred) soft folder, may be applied to the edges where the plates overlap, and to the edges of the joint-covers, that will likewise render them air-tight: upon the whole, it will be found that these anti-corrosion plates form the best, the most elegant, and the cheapest roof ever yet exhibited.

Besides the purposes already enumerated, this preparation will be found important, as well as from its silvery appearance highly ornamental in all iron work about shipping, in fish-hooks* for the Newfoundland and other fisheries, iron rails, gates, palisadoes, iron-work about steam-engines, oil cauldrons, jars, hoops for all sorts of vats and casks, iron chains of all descriptions, curtain and stair-case carpet-rods and hooks, coach and cart harness furniture, fadler's ironmongery in general, bolts

* The fishermen keep their hooks as bright as they can to attract the eye of the fish—in doing this they consume much labour and time. The anti-corrosion hooks, being always bright of themselves, will therefore for this fishery be a valuable article.

and

and hinges for doors, &c. iron works about mills, locks, water-works and pipes, iron, brass and copper wire-work, skewers, nails, screws, tacks, tenter-hooks, and all other moveable articles, liable, from any cause, to rust or corrode.

Our lead mines are at present of little or no value, unless the ore be strongly impregnated with silver; and lead (except for culinary vessels and articles, in which ornament is as much to be considered as utility) is a constituent of the anti-corrosion preparation. The use of lead therefore, in anti-corrosion, in case it should get into general use, will raise the value of that article, and in a great measure restore to importance a plentiful native production of our country, while it will, in its application, render iron, another native production, of far more importance in manufacture than it is of at present. The markets of America, Africa, and Asia, where iron is apt to rust, as soon as the inhabitants of those parts know the value of the anti-corrosion invention, may easily be expected to open for the reception of its various produce; and our native metals, in this new and happy combination of them, may thus become an important new source of national wealth.

The prepared iron bolts, nails, and other metallic works for shipping, must be necessary and important to America from another consideration:—as the Americans build their ships of green timber, the vegetable juices so rapidly corrode mere iron-work, that the bolts and

nails are soon reduced to rust, by which their ships are speedily rendered dangerous and unserviceable.

This preparation is so slightly soluble in vegetable acids, that it may be difficult to say how long a ship, built of green cedar, with anti-corrosion metal works, would last.

This would open a new commerce with various states, but particularly with the Americans; and from America I should have some articles to import in return, of equal, if not greater importance to Great-Britain.

But this I forbear at present to enlarge upon, as it is intended for a future tract of my "ATTEMPT."

CONCLUSION.

THE vast advantages that must result to this country, from a complete execution of the designs I have made, cannot but be perceived by every intelligent reader. I shall therefore refrain from going into them minutely, but barely remark in general, that I presume the establishment of an Anti-corrosion Manufactory, on a scale calculated to answer the

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the various purposes to which I have asserted its applicability, will be the means of removing the present alarming scarcity and dearth of copper; of producing a valuable succedaneum for copper sheathing, bolts, nails, and other metallic works in ship-building; of preventing the losses of our most valuable ships and seamen; of securing the purposes of health; of increasing the value of some of our mines; of rendering iron, tin, and lead, the universal articles for purposes of great consumption, both at home and abroad; of improving, in a great degree, civil as well as naval architecture; of ~~tempering and more justly~~ balancing our different metallic trades and manufactures; and, in fine, of promoting in a variety of ways the highest commercial and political interests of Great-Britain.

But as the execution of designs, at once so extensive and important as these, must unavoidably baffle individual exertion; in order to carry them into effect, in the most accommodating and general way, ~~I have formed Companies to execute and carry on~~ the manufacture on such a scale, that some town, in every eligible part of the kingdom, shall have a warehouse, stocked with every necessary article; from which plan the different sea-ports may be expeditiously supplied with nails, bolts, sheathing, &c. &c.; the inhabitants of all parts of the kingdom may, with convenience, exchange their copper, brass, and pot-metal vessels, for those of the new manufacture; and the whole scheme, in all its branches, may be at once universally beneficial to all ranks and classes of people.

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In bringing these designs to perfection, and preparing to publish this account of them, I have been at considerable expence as well as pains; I therefore humbly presume to hope for the respective patronage and encouragement of the several branches of the British legislature, and of every liberal-minded man among Britons, in my endeavours to realize the views I have here attempted to lay open.

Although I am not conscious of having mistated ^{any} facts, or drawn any inferences ^{that are not} ~~from these, than what are~~ fair and obvious, I cannot close this essay, without again deprecating the indifference that is too commonly and too generally shewn to projects and projectors of all kind; especially in cases, which (like the present) combine with the publick interests some very important ones of a private individual. Such, however, are the energies of truth and justice, that if the views, which I have endeavoured to represent, of the many and momentous objects of my design, be not absolutely imaginary, the ends I have proposed, should ^{they be unattended to now, must and inevitably will} ~~be accomplished by some other person at some future time: and will be inevitably accomplished~~ As a patriot, it is with no small consolation, that I entertain even this hope of distant success to an undertaking, that I believe to be pregnant of many effects auspicious to my native country, while both in my publick and private consideration of it, I cannot but wish such a design immediately followed up by superior attention and countenance. ~~My~~ Men do not now live to antediluvian ages, ^{and}—To rescue the assertors of truth from the dominion of ignorance, prejudice, and selfish partiality;—to correct the inequalities that,

that, in the present period of human life, are too often found in the distribution of rewards as well as punishments;—and, to give what is due to either merit or demerit, are among the ~~primary duties of all governments.~~ *highest interests, and consequently among the first duties, of all governments, and of all society.*

WILLIAM LANGWORTHY.

January 30th, 1793.



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A P P E N D I X.

I Do not mean to arrogate to myself more love for my country than I ought to possess; yet, I think it will be doing myself no more than justice, to publish the following certificates of my conduct, shortly before the commencement of the present war between England and France.

CERTIFICATE

OF

EVAN NEPEAN, Esq;

UNDER SECRETARY OF STATE FOR THE HOME DEPARTMENT.

Home Department.

Secretary of State's Office, Feb. 13, 1794.

I hereby certify that in December 1792, a gentleman describing himself to be Captain CHARLES JAMES, and to have returned lately from France gave me the following information:

That Mr. LANGWORTHY, the proprietor of a certain discovery for the prevention of corrosion in Iron, had received, through him, an offer from France, of an immediate contract for the application of his contrivance, to the preservation of twelve hundred thousand musquets and bayonets, and seven hundred thousand pikes; which contract, he said, if

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fulfilled,

fulfilled, would, according to Mr. LANGWORTHY's calculation, have netted an hundred thousand pounds sterling; twenty thousand pounds to have been immediately paid down in England, and the remainder as the execution of the contract proceeded:

That it being rumoured that a war between Great-Britain and France was expected to take place, the object and purpose of the application to me was, to be informed whether the rumour was founded on real expectations of the British Ministry, or merely popular:

That in the first case, it was Mr. LANGWORTHY's determined resolution, from the purest motives of patriotism, to decline the French Ministers offer; and that only in the latter case, and upon the firmest assurance that peace with France was likely to continue, he should consider himself justified in accepting it.

In answer to this application of Mr. LANGWORTHY's friend, I informed him, that, as to the question of peace or war, I could say nothing to him on the subject; that Mr. LANGWORTHY was the best judge, how far he could, consistently with his duty as a British subject, throw such an advantage as he stated would be derived from his invention, into the hands of France, and that, placing myself in his situation, I should certainly decline any overture of the nature which had been made him by France.

(Signed)

EVAN NEPEAN.

CERTIFICATE

CERTIFICATE

OF

CHARLES JAMES, Esq;

Captain in the Western Regiment of Middlesex Militia.

I hereby certify, that on the 22d day of November 1792, being at Paris, and having with me some iron articles which had undergone Mr. LANGWORTHY's process for preventing rust in that metal, and had been presented to me as a curiosity, I shewed them to RABAUT DE ST. ETIENNE, and mentioned to him that the invention was applicable to arms.

This ingenious gentleman immediately requested my permission to lay the specimens before M. PACHE, then Minister of the War Department, to which I consented, and it was done.

I was shortly after desired to write to the Proprietor to know the price at which he would prepare twelve hundred thousand musquets and bayonets, and seven hundred thousand pikes, and whether the preparation could be used for cannon?

I returned to England in the latter end of December, to obtain a definitive answer from Mr. LANGWORTHY, relative to two proposals I had to make to him. On my return it was rumoured, that a war between
England

England and France could not well be avoided; upon which I went to the Secretary of States Office, and submitted to Mr. NEPEAN the particulars partly stated in his certificate; and, in addition to what is there set forth, requested to know whether, in the situation that affairs were then in, there would be any criminality or impropriety (considering myself as a British Officer) in my negotiating any further, or in Mr. LANGWORTHY's (as a British subject) closing with the French offers; as I was to give an answer by that night's post.

To which Mr. NEPEAN replied, that as there was no war between England and France then subsisting, there certainly would be no criminality, either in my negotiating, or in Mr. LANGWORTHY's closing the contract, or acceding to any proposals made him by the French Ministry on that subject;—that with respect to the war's taking place, he could say nothing on that head, but that were *he* in *my* situation, he should certainly decline any further negotiation with France; that with respect to Mr. LANGWORTHY, *he* was the best judge how far he was justified, as a British subject; in throwing such advantages into the hands of France, as his contrivances were calculated to effect; and that were he (Mr. NEPEAN) in Mr. LANGWORTHY's situation, he should certainly reject any overture from France, of the nature which had been made him by the Ministry of that country.

I communicated to Mr. LANGWORTHY the purport of what Mr. NEPEAN had said, and informed him at the same time, that I should
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from henceforth renounce all correspondence with France, and that after considering of the great wealth he might acquire, on the one hand, and the substance of Mr. NEPEAN's opinion on the other, he might act with the French ministry as he pleased.

Mr. LANGWORTHY, rather than give an advantage to a nation likely to become an enemy to his country, instantly sacrificed, with the greatest cheerfulness, the many and vast emoluments which must have accrued to him, had he accepted either of the two proposals offered him by the French; one of which, I am now at liberty to say, was a specific sum to be paid to Mr. LANGWORTHY in England, for the full communication of the secret; and the other was, that he should be paid for the preparation of the quantity of arms before mentioned, as stated in Mr. NEPEAN's certificate, for which he should himself superintend a manufactory to be erected for the purpose in the neighbourhood of Paris, and at the expence of France.

By the post subsequent to these conversations with Mr. NEPEAN and Mr. LANGWORTHY, I wrote to M. RABAUT DE ST. ETIENNE, that from the situation of things in England, I could no longer negotiate with France; and that my friend, the proprietor of the preparation in question, from the same cause, declined to accept both the offers made to him, through me, by the French ministry.

(Signed)

CHARLES JAMES,

Gosport, Head Quarters,

Captain W. M. M.

Feb. 18th, 1794.

Copy of a letter from CAPTAIN JAMES, inclosing the above Certificate.

TO WILLIAM LANGWORTHY, esq; Essex-street, London.

Dear Sir,

I take the earliest moment to transmit to you the certificate you request to have, relative to the contract which I had negotiated in Paris.

The sudden change of affairs in that capital, and the likelihood of the rupture, which has since taken place, between the English and French nations, having induced you to reject the offers of the French Ministry, at the time I declined any further negotiation with them, I sincerely hope you may be able to convince the Government of this country, that what appeared highly beneficial to our neighbours on this subject, is equally advantageous to ourselves. I am free to confess, for my part, that nothing has ever struck me more forcibly than the necessity of some preparation to preserve fire-arms, &c. from corrosion in this island. The most trifling exposure to free air, especially upon the coast, defeats every effort of the soldier to keep his musquet in proper condition; and, should the pike be adopted amongst us, which it may probably be, I do not conceive it possible for any thing to be so immediately necessary as your metallic composition. If it can be used, (as I was very properly asked by RABAUT De ST. ETIENNE) for the preservation of the most material points in gunnery, namely the inside and touch-hole of a cannon, the secret will be additionally valuable.

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At all events, I think it cannot fail of attracting the notice of the Minister; for however I may have differed from him in some political points, in the management of internal concerns or external operations, I have too great an opinion of his commercial talents and patriotism, to believe he will suffer so advantageous a discovery to lie neglected in this country, (especially at a crisis when it is of so much national importance as at the present) on your laying before him a state of it in the way you have mentioned to me.

I am extremely happy that you are in possession of Mr. NEPEAN's certificate, as it will corroborate my own, and not only promote your views, but contribute perhaps to a removal of some prejudice, which has existed against me, from a misunderstanding of the freedom with which I have both spoken and written my sentiments on French affairs. To describe the state of the publick mind in hours of commotion, is not to recommend the horrors that are too frequently consequent on them, but to erect a beacon for the prevention of similar calamities. From principles of this sort I endeavour to be useful; if they are perverted it is not my fault.

" Nullius addictus jurare in verba magistri,

" Quo me cunque rapit tempestas, ^{superior} ~~inferior~~ hospes.

Yours, faithfully,

Gosport, Head Quarters,

Feb. 18th, 1794.

CHARLES JAMES.

To these certificates I shall only add, that, at the time I rejected the offers of France, stated by Mr. NEPEAN and Captain JAMES, by which I should have netted at least one hundred thousand pounds, I had recently met with such disappointments from the failure of some merchants in London with whom I was connected, that, from an apparent state of considerable opulence, I was reduced to almost absolute want.

Feb. 22d, 1794.

W. L.



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